

## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

KOLSTER OY AB  
Iso Roobertinkatu 23  
P.O. Box 148  
FIN-00121 Helsinki  
C  
FINLANDERECEIVED  
MAY 16 2001  
TC 2600 MAILROOM

Date of mailing (day/month/year) 21 March 2001 (21.03.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference T298060PC/su	
International application No. PCT/FI99/00635	International filing date (day/month/year) 21 July 1999 (21.07.99)

## 1. The following indications appeared on record concerning:

☐ the applicant    ☐ the inventor    ☒ the agent    ☐ the common representative

## Name and Address

PATENTTITOIMISTO TEKNOPOLIS  
KOLSTER OY  
c/o Kolster Oy AB  
Iso Roobertinkatu 23  
P.O. Box 148  
FIN-00121 Helsinki  
Finland

## State of Nationality

## State of Residence

## Telephone No.

+ 358 9 618 821

## Facsimile No.

+ 358 9 602 244

## Teleprinter No.

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person    ☒ the name    ☐ the address    ☐ the nationality    ☐ the residence

## Name and Address

KOLSTER OY AB  
Iso Roobertinkatu 23  
P.O. Box 148  
FIN-00121 Helsinki  
Finland

## State of Nationality

## State of Residence

## Telephone No.

+ 358 9 618 821

## Facsimile No.

+ 358 9 602 244

## Teleprinter No.

## 3. Further observations, if necessary:

## 4. A copy of this notification has been sent to:

☒ the receiving Office    ☐ the designated Offices concerned  
☐ the International Searching Authority    ☒ the elected Offices concerned  
☐ the International Preliminary Examining Authority    ☐ other:
The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

## Authorized officer

F. Baechler

Telephone No.: (41-22) 338.83.38

## .TENT COOPERATION TRE. Y

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

PATENTTITOIMISTO TEKNOPOLIS  
KOLSTER OY  
C/O Kolster Oy Ab  
Iso Roobertinkatu 23  
P.O. Box 148  
FIN-00121 Helsinki  
FINLANDE

Date of mailing (day/month/year)  
28 October 1999 (28.10.99)

Applicant's or agent's file reference  
T298060PC/su

International application No.  
PCT/FI99/00635

## IMPORTANT NOTIFICATION

International filing date (day/month/year)  
21 July 1999 (21.07.99)

## 1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

## Name and Address

NOKIA TELECOMMUNICATIONS OY  
Keilalahdentie 4  
FIN-02150 Espoo  
Finland

## State of Nationality

FI

## State of Residence

FI

Telephone No.

Facsimile No.

Teleprinter No.

## 2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

## Name and Address

NOKIA NETWORKS OY  
Keilalahdentie 4  
FIN-02150 Espoo  
Finland

## State of Nationality

FI

## State of Residence

FI

Telephone No.

Facsimile No.

Teleprinter No.

## 3. Further observations, if necessary:

## 4. A copy of this notification has been sent to:

☒ the receiving Office ☒ the designated Offices concerned  
☒ the International Searching Authority ☐ the elected Offices concerned  
☐ the International Preliminary Examining Authority ☐ other:

The International Bureau of WIPO  
34, chemin des Colombettes  
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Kari Huynh-Khuong

Telephone No.: (41-22) 338.83.38

## PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents  
 United States Patent and Trademark  
 Office  
 Box PCT  
 Washington, D.C.20231  
 ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

<b>Date of mailing</b> (day/month/year) 20 March 2000 (20.03.00)	
<b>International application No.</b> PCT/FI99/00635	<b>Applicant's or agent's file reference</b> T298060PC/su
<b>International filing date</b> (day/month/year) 21 July 1999 (21.07.99)	<b>Priority date</b> (day/month/year) 22 July 1998 (22.07.98)
<b>Applicant</b> HOLMA, Harri et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
 28 January 2000 (28.01.00)

☐ in a notice effecting later election filed with the International Bureau on:  
 \_\_\_\_\_

2. The election ☒ was

☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No.: (41-22) 740.14.35	Authorized officer  Aino Metcalfe  Telephone No.: (41-22) 338.83.38
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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00635

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
IPC7: H04B 7/26, H04J 13/02 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
IPC7: H04B, H04J		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
SE,DK,FI,NO classes as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
WPIL, EDOC, INTERNET, INSPEC		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 9523464 A1 (MOTOROLA, INC.), 31 August 1995 (31.08.95), figure 3, claims 1-10 --	1,6,8,16,21, 23,31,36,38
Y	EP 0693834 A1 (NTT MOBILE COMMUNICATIONS NETWORK INC.), 24 January 1996 (24.01.96), column 6, line 32 - column 8, line 54, figure 6, claims 1-44 --	1,6,8,16,21, 23,31,36,38
Y	US 5442625 A (RICHARD D. GITLIN ET AL), 15 August 1995 (15.08.95), column 1, line 45 - line 59, figure 5, claims 1-14 --	1,6,8,16,21, 23,31,36,38
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
14 December 1999		04 -01- 2000
Name and mailing address of the ISA Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86		Authorized officer Klas Arvidsson/mj Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00635

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9605669 A1 (UNISYS CORPORATION), 22 February 1996 (22.02.96), page 3, line 5 - line 36, claims 1-19 --	1,5,16,20, - 31,35
A	WO 9512259 A1 (NOKIA TELECOMMUNICATIONS OY), 4 May 1995 (04.05.95), page 4, line 17 - page 6, line 7, claims 1-13 --	1,3,16,18, 31,33
A	EP 0797369 A2 (NTT MOBILE COMMUNICATIONS NETWORK IN C.), 24 Sept 1997 (24.09.97), column 3, line 15 - column 5, line 19, claims 1-30 -----	1,16,31

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/FI 99/00635

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
WO	9523464	A1	31/08/95	CA	2158269 A	31/08/95
				EP	0700612 A	13/03/96
				JP	8509590 T	08/10/96
EP	0693834	A1	24/01/96	JP	57210254 A	23/12/82
				US	5673260 A	30/09/97
				CN	1124552 A	12/06/96
				JP	2801967 B	21/09/98
				WO	9522213 A	17/08/95
US	5442625	A	15/08/95	CA	2145708 A	14/11/95
				EP	0682423 A	15/11/95
				JP	8065273 A	08/03/96
				US	5856971 A	05/01/99
WO	9605669	A1	22/02/96	AU	698991 B	19/11/98
				AU	3327695 A	07/03/96
				CA	2197757 A	22/02/96
				EP	0776556 A	04/06/97
				JP	10504154 T	14/04/98
				US	5499236 A	12/03/96
				US	5583853 A	10/12/96
WO	9512259	A1	04/05/95	AU	685523 B	22/01/98
				AU	7995094 A	22/05/95
				CN	1134205 A	23/10/96
				EP	0725999 A	14/08/96
				FI	934759 A	28/04/95
				JP	9507114 T	15/07/97
				NO	961699 A	26/04/96
				US	5799004 A	25/08/98
EP	0797369	A2	24/09/97	CA	2200518 A	21/09/97
				CN	1165459 A	19/11/97
				JP	9312885 A	02/12/97

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 29 DEC 2000

WIPO PCT

Applicant's or agent's file reference T298060PC/nu	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/FI99/00635	International filing date (day/month/year) 21/07/1999	Priority date (day/month/year) 22/07/1998
International Patent Classification (IPC) or national classification and IPC7 H04B 7/26, H04J 13/02		
Applicant Nokia Networks OY, et al		

- This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 5 sheets, including this cover sheet.  
☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).  
These annexes consist of a total of \_\_\_\_\_ sheets.

- This report contains indications relating to the following items:
  - ☒ Basis of the report
  - ☐ Priority
  - ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
  - ☐ Lack of unity of invention
  - ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
  - ☐ Certain documents cited
  - ☐ Certain defects in the international application
  - ☐ Certain observations on the international application

Date of submission of the demand 28/01/2000	Date of completion of this report 20/12/2000
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88	Authorized officer Klas Arvidsson/JAn Telephone No. 08-782 25 00

Form PCT/IPEA/409 (cover sheet) (January 1998)

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI99/00635

**I. Basis of the report****1. With regard to the elements of the international application:\***

- ☒ the international application as originally filed
- ☐ the description:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the claims:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, as amended (together with any statement) under article 19  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the drawings:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_
- ☐ the sequence listing part of the description:  
pages \_\_\_\_\_, as originally filed  
pages \_\_\_\_\_, filed with the demand  
pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

**2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.**

These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

**3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:**

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

**4. ☐ The amendments have resulted in the cancellation of:**

- ☐ the description, pages \_\_\_\_\_
- ☐ the claims, Nos. \_\_\_\_\_
- ☐ the drawings, sheet/fig \_\_\_\_\_

**5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\***

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.



## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI99/00635

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims	<u>1-43</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-43</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-43</u>	YES
	Claims		NO

**2. Citations and explanations (Rule 70.7)**

The present invention relates to the use of spreading codes in a universal mobile telephone system.

The invention is intended to overcome the problem concerning efficient use of a limited radio resource. If one spreading code is reserved for each user a problem occurs when control data and continuous user data are to be transmitted simultaneously. Also, for user equipment in slotted mode a problem occurs when the user equipment measures the received power of other frequencies of adjacent base stations for part of the duration of the radio frame, which results in that said equipment cannot receive normally and may even lose the entire radio frame.

The solution of the problem according to the independent claims 1, 16 and 31 is a method for transmitting data from a radio network subsystem over a radio link to a user equipment in a mobile system, where a dedicated physical control channel and a dedicated physical data channel are formed by frames to be transmitted over the radio link. During transmission said radio network subsystem spreads each channel with a spreading code, dependent of the transmission rate, or employs a spreading code that is reserved, in normal situations. The radio system is adapted to spread in a special situation at least one frame of a dedicated physical data channel with a shared spreading code that is shorter than the spreading code used in normal situations, and to share the shared spreading code by time division between the dedicated physical data channels of at least two different radio links.

.../...

**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**

International application No.

PCT/FI99/00635

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: BOX V

The following documents have been cited:

D1: WO, 9 523 464, A1

D2: EP, 0 693 834, A1

D3: US, 5 442 625, A

Document D1 discloses a method of time division multiplexing the use of spreading codes in a communications system (see claim 1). Said system encompasses time division multiplexing data from a first and a second user to produce multiplexed first and second user information and spreading this multiplexed first and second user information with a common spreading code.

From document D2 it is known a communication method in a CDMA mobile communication system involving base stations and at least one mobile station communicating through radio channels, comprising selecting one of many short spreading codes and transmit data by using said spreading code and a long spreading code which is longer than said short spreading code.

Document D3 presents a CDMA system that allows a user at a radio transmitter to dynamically change its source data rate. Responding to a user input selecting one of a plurality of source bit rates, an adjustable coding means spreads and transmits the user's data received at one bit rate to a channel bit rate which at least equals the highest bit rate of the plurality of source bit rates.

The invention according to the independent claims 1, 16 and 31 differs from what is disclosed by document D1, i.e. sharing a common code by time division between two different data channels, in that the independent claims 1, 16 and 31 specify two different spreading codes and that a first shared (i.e. common) spreading code is shorter than a second spreading code that is used in normal situations.

The invention according to the independent claims 1, 16 and 31 differs from what is known from document D2, i.e. selection of and transmission of data using a first and a second spreading code, of which one is shorter than the other, in that the independent claims 1, 16 and 31 specify the usage of a shared spreading code that is shared by time division between two dedicated data channels.

.../...

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI99/00635

**Supplemental Box**

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Box V

Document D3 specifies a feature relevant to the invention according to the independent claims 1, 16 and 31, a system in which a transmitter dynamically changes its data rate by adjusting a spreading code and transmit data using said adjusted spreading code as a response to a user input.

Even though the cited documents relate to the subject claimed in the independent claims 1, 16 and 31, a combination of a feature of document D1, sharing a common spreading code by time division between two different data channels, and a certain feature of document D2, i.e. selection of and transmission of data using a first and a second spreading code, of which one is shorter than the other, would result in a method using a first shared spreading code that is shorter than a second spreading code, and to share the shared spreading code by time division between two different data channels. The invention according to the independent claims 1, 16 and 31, however differs from the system created by a combination of features from documents D1 and D2, in respect of that the invention describes a method sharing a spreading code that is shorter than the one used in normal situations, by time multiplexing two data channels of different radio links. This enables a quick change of the transmission rate by selecting a suitable spreading code.

Consequently, the invention according to claims 1- 43 is a novelty and involves an inventive step. It does also comprise industrial applicability.

## PCT REQUEST

T298060PC/su

Original (for SUBMISSION) - printed on 21.07.1999 12:56:55 PM

0	For receiving Office use only	
0-1	International Application No.	PCT/FI 99 / 0 0 6 3 5
0-2	International Filing Date	21 JUL 1999 (21.07.99)
0-3	Name of receiving Office and "PCT International Application"	The Finnish Patent Office PCT International Application
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared using	PCT-EASY Version 2.84 (updated 01.07.1999)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	National Board of Patents and Registration (Finland) (RO/FI)
0-7	Applicant's or agent's file reference	T298060PC/su
I	Title of invention	DATA TRANSMISSION METHOD, RADIO NETWORK SUBSYSTEM, AND USER EQUIPMENT
II	Applicant	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	NOKIA TELECOMMUNICATIONS OY
II-5	Address:	Keilalahdentie 4 FIN-02150 Espoo Finland
II-6	State of nationality	FI
II-7	State of residence	FI
III-1	Applicant and/or inventor	
III-1-1	This person is:	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	HOLMA, Harri
III-1-5	Address:	Itätuulenkuja 1 B 32 FIN-02100 Espoo Finland
III-1-6	State of nationality	FI
III-1-7	State of residence	FI

## PCT REQUEST

T298060PC/su

Original (for SUBMISSION) - printed on 21.07.1999 12:56:55 PM

III-2	Applicant and/or inventor	<b>applicant and inventor</b> <b>US only</b> <b>TOSKALA, Antti</b> <b>Katajaharjuntie 4 C 48</b> <b>FIN-00200 Helsinki</b> <b>Finland</b> <b>FI</b> <b>FI</b>
III-2-1	This person is:	
III-2-2	Applicant for	
III-2-4	Name (LAST, First)	
III-2-5	Address:	
III-2-6	State of nationality	
III-2-7	State of residence	
IV-1	Agent or common representative; or address for correspondence The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	<b>agent</b>  <b>PATENTTITOIMISTO TEKNOPOLOIS KOLSTER OY</b> <b>C/O Kolster Oy Ab</b> <b>Iso Roobertinkatu 23</b> <b>P.O. Box 148</b> <b>FIN-00121 Helsinki</b> <b>Finland</b> <b>+ 358 9 618 821</b> <b>+ 358 9 602 244</b> <b>Kolster@Kolster.Fi</b>
IV-1-1	Name	
IV-1-2	Address:	
IV-1-3	Telephone No.	
IV-1-4	Facsimile No.	
IV-1-5	e-mail	
V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	<b>AP: GH GM KE LS MW SD SL SZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT</b> <b>EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT</b> <b>EP: AT BE CH&amp;LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT</b> <b>OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT</b>

## PCT REQUEST

T298060PC/su


Original (for SUBMISSION) - printed on 21.07.1999 12:56:55 PM

V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AL AM AT (patent and utility model) AU AZ BA BB BG BR BY CA CH&LI CN CU CZ (patent and utility model) DE (patent and utility model) DK (patent and utility model) EE (patent and utility model) ES FI (patent and utility model) GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK (patent and utility model) SL TJ TM TR TT UA UG US UZ VN YU ZA ZW	
V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	Exclusion(s) from precautionary designations	NONE	
VI-1	Priority claim of earlier national application		
VI-1-1	Filing date	22 July 1998 (22.07.1998)	
VI-1-2	Number	981649	
VI-1-3	Country	FI	
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)	
VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	17	-
VIII-3	Claims	8	-
VIII-4	Abstract	1	t298060p.txt
VIII-5	Drawings	11	-
VIII-7	TOTAL	41	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-10	Copy of general power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-18	Figure of the drawings which should accompany the abstract	6A and 6B	
VIII-19	Language of filing of the international application	English	

## PCT REQUEST

T298060PC/su

Original (for SUBMISSION) - printed on 21.07.1999 12:56:55 PM

IX-1	Signature of applicant or agent	
IX-1-1	Name	Krister Dahlström PATENTTITOIMISTO TEKNOLOGIS KOLSTER OY

## FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	21 JUL 1999 ( 21 -07- 1999 )
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
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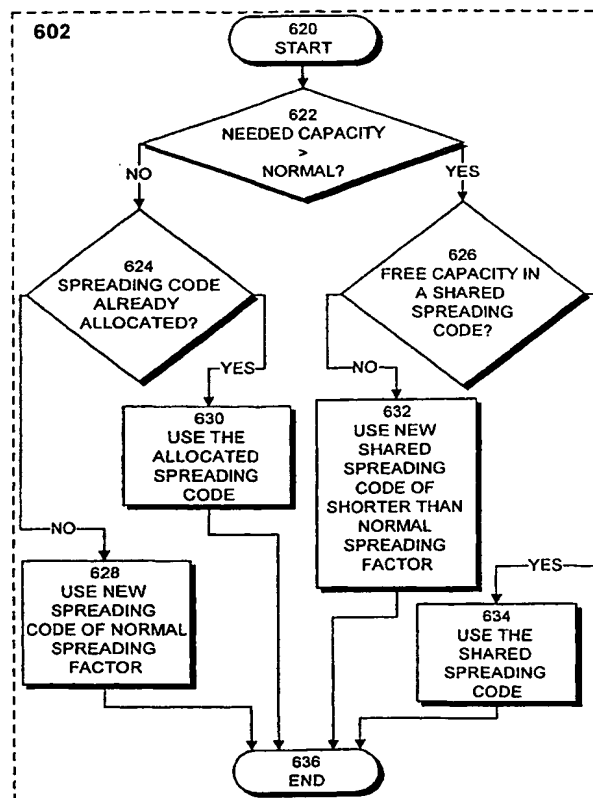
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(54) Title: DATA TRANSMISSION METHOD, RADIO NETWORK SUBSYSTEM, AND USER EQUIPMENT

## (57) Abstract

The invention relates to a method for transmitting data from a radio network subsystem (RNS) over a radio link (Uu) to user equipment (UE) in a mobile telephone system, a radio network subsystem, and user equipment. The radio network subsystem (RNS) transmits (604, 606) a dedicated physical channel to the user equipment (UE). The dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel. The dedicated physical channel is formed by frames to be transmitted to the radio link (Uu). During transmission, the radio network subsystem (RNS) spreads (608, 610) each channel with a spreading code, the length of which spreading code, i.e. spreading factor, determines the data transmission rate. A spreading code is reserved for use by the radio link (Uu) in normal situations. In special situations (602), at least one frame of the dedicated physical data channel is spread with a shared spreading code. A shared spreading code is shorter than a spreading code used in a normal situation. The shared spreading code in question is shared by time division between the dedicated physical data channels of at least two different radio links (Uu).





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## DATA TRANSMISSION METHOD, RADIO NETWORK SUBSYSTEM, AND USER EQUIPMENT

### FIELD OF THE INVENTION

5 The invention relates to a method for transmitting data from a radio network subsystem to user equipment in a mobile telephone system. In particular, the invention relates to the use of spreading codes in a universal mobile telephone system.

### BACKGROUND OF THE INVENTION

10 One of the biggest problems in mobile telephone systems is an efficient use of a limited radio resource. In present systems, a certain quantity of resources, for instance one spreading code, is reserved for each user for a circuit switched call during the entire radio link. The problem occurs, because not only is user data continuously transmitted, but system control data must also be transmitted at sporadically or regularly repeating intervals. Another  
15 problem relates to the operation of user equipment in slotted mode, in which the user equipment measures the received power of other frequencies of adjacent base transceiver stations for part of the duration of the radio frame. In this case, the user equipment cannot receive normally, but may even lose the entire radio frame.

20 For instance, in systems using the code division multiple access method (CDMA) one spreading code with spreading factor 256 is reserved for each connection on a downlink from the radio network subsystem to the user equipment. This spreading factor is enough to transmit user data, but when it is necessary to transmit control data, coding must be cut down too much. One  
25 solution to the problem is to replace user data with system control data, but in this case some of the user data would be lost, and when transmitting speech, for instance, this would be noticeable as a decrease in speech quality, even breaking.

30 Another solution to the first problem is to reserve data transmission resources in a manner that there is enough of them all the time. In this case, a spreading code with spreading factor 128, for instance, is reserved for the connection. A problem occurs, however, because the need for transmission resources is calculated on the basis of the momentary maximum required and thus transmission resources are wasted during most of the time when control  
35 data need not be transmitted. In theory, it is possible to use 128 different

spreading codes simultaneously, but, as in certain cases even 25 to 30% of users are performing soft handovers at the same time, there are, in practice, less than a hundred spreading codes left to use.

Used spreading codes can be arranged in a code tree in which the spreading codes used in the system are arranged mutually orthogonally. When moving deeper into the tree, the length of the spreading codes doubles on each level, thus halving the data transmission speed. One suggested solution to the second problem above is that adjacent spreading codes on one level, i.e. sibling codes, be reserved for two different users. The spreading factor of the sibling codes can be 256, for instance. When necessary, one of the users can then obtain the parent code of said spreading codes, i.e. a code one level up with spreading factor 128. However, this solution entails that the users are synchronized with each other, because the first user cannot use its own sibling code while the second user uses the parent code. The first user equipment can thus make measurements during the first half of a normal frame and receive a shortened frame spread with the parent code during the second half, in which case its data transmission capacity corresponds to a normal frame spread with the sibling code. The second user equipment receives a shortened frame spread with the parent code during the first half of the frame and makes measurements during the second half. In normal operation, both sets of user equipment receive normal frames spread with their own sibling codes. The required synchronization is a considerable limitation to the flexibility of the system.

#### BRIEF DESCRIPTION OF THE INVENTION

It is thus an object of the invention to develop a method and an apparatus implementing the method in a manner that solves the above problems. This object is achieved by a method described in the following. It is a method for transmitting data from a radio network subsystem over a radio link to user equipment in a mobile telephone system, which comprises: the radio network subsystem transmits a dedicated physical channel to the user equipment, which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and the dedicated physical channel is formed by frames to be transmitted to the radio link; during transmission, the radio network subsystem spreads each channel with a spreading code, the length of which spreading code, i.e. spreading factor,

determines the data transmission rate, and a spreading code to be used in normal situations is reserved for the radio link. In the method in question, in a special situation at least one frame of the dedicated physical data channel is spread with a shared spreading code which is shorter than the spreading code  
5 used in normal situations, and the shared spreading code in question is shared by time division between the dedicated physical data channels of at least two different radio links.

A further object of the invention is a radio network subsystem which is adapted to transmit a dedicated physical channel over a radio link to the  
10 user equipment, which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and to form a dedicated physical channel from the frames to be transmitted to the radio link; to spread each channel with a spreading code during transmission, the length of which spreading code, i.e. spreading factor, determines the data  
15 transmission rate, and to reserve a spreading code to be used in normal situations for the radio link. The radio system is adapted to spread in a special situation at least one frame of the dedicated physical data channel with a shared spreading code which is shorter than the spreading code used in normal situations, and to share the shared spreading code in question by time  
20 division between the dedicated physical data channels of at least two different radio links.

A yet further object of the invention is user equipment which is adapted to receive a dedicated physical channel transmitted by the radio network subsystem over a radio link, which dedicated physical channel  
25 comprises a dedicated physical control channel and a dedicated physical data channel, and to form a dedicated physical channel from the frames to be received from the radio link; to remove during reception the spreading of each channel with a spreading code, the length of which spreading code, i.e. spreading factor, determines the data transmission rate, and to use in normal  
30 situations the spreading code reserved for the radio link for normal situations to remove the spreading. In special situations, the user equipment is adapted to remove the spreading of at least one frame of the dedicated physical data channel with a shared spreading code which is shorter than the spreading code used in normal situations and which is used by time division between the  
35 dedicated physical data channels of at least two different radio links.

The preferred embodiments of the invention are set forth in the dependent claims.

5 The invention is based on the fact that a common code resource distributed to different radio links is reserved for the spreading of dedicated physical data channels. In normal situations, each radio link uses its own code resource, but in special situations, a radio link can use the shared code resource. The individual code resource of a radio link and the shared code resource are in no way dependent on each other, i.e. they can be used simultaneously.

10 The method of the invention provides several advantages. The data transmission rate can be changed quickly, even specifically for each frame, by selecting a suitable spreading code. This enables an efficient utilization of radio resources.

#### BRIEF DESCRIPTION OF THE DRAWINGS

15 In the following, the invention will be described in greater detail in connection with preferred embodiments and with reference to the attached drawings, in which

Figures 1A and 1B show a mobile telephone system,

20 Figure 2A shows a transmitter and receiver of a mobile telephone system,

Figure 2B illustrates the spreading and modulation performed in a transmitter,

Figure 3 shows the channels of a mobile telephone system set in frames,

25 Figure 4A shows a code tree,

Figure 4B illustrates the allocation of codes according to the invention,

Figure 5 shows user equipment,

30 Figures 6A and 6B show flow charts illustrating action of the invention,

Figure 7A illustrates sharing of the use of a spreading code according to the invention, and

Figure 7B shows an enlarged detail of Figure 7A, which illustrates how different spreading codes can be used within a frame.

## DETAILED DESCRIPTION OF THE INVENTION

The invention can be used in various mobile telephone systems that use the code division multiple access method (CDMA). The examples illustrate the use of the invention in a universal mobile telephone system using a direct-  
5 sequence wide-band code division multiple access method, without limiting the invention to it, however. Thus, for instance the IMT-2000 mobile telephone system developed by ARIB (Association of Radio Industries and Businesses) in Japan is a system of the invention. The examples are based on the specification of the WCDMA system, further information on which is available  
10 in the ETSI (European Telecommunications Standards Institute) specification "The ETSI UMTS Terrestrial Radio Access (UTRA) ITU-R RTT Candidate Submission (Tdoc SMG2 260/98, May/June 1998), which is incorporated herein by reference.

The structure of a universal mobile telephone system is described  
15 with reference to Figures 1A and 1B. Figure 1B includes only the blocks that are essential for describing the invention, but it is obvious to those skilled in the art that a common mobile telephone system also contains other functions and structures which need not be described in detail herein. The main parts of a mobile telephone system are a core network CN, a universal mobile  
20 telephone system (UMTS) terrestrial radio access network UTRAN, and user equipment UE. The interface between CN and UTRAN is referred to as Iu and the air interface between UTRAN and UE is referred to as Uu.

UTRAN comprises radio network subsystems RNS. The interface  
25 between RNSs is referred to as Iur. An RNS comprises a radio network controller RNC and one or more nodes B. The interface between RNC and B is referred to as Iub. The service area of node B, i.e. cell, is indicated with C in Figure 1B.

As the presentation in Figure 1A is very abstract, it is therefore  
30 clarified in Figure 1B by setting forth the parts of the GSM system that approximately correspond with the parts of the UMTS. It should be noted that the mapping shown is by no means a binding one but an approximation, since the responsibilities and functions of the different parts of the UMTS are still being planned.

As shown in Figure 1B, a circuit-switched connection can be  
35 established from user equipment UE to a phone 100 in a public switched telephone network (PSTN) 102. The user equipment UE can, for instance, be

a fixed terminal, a terminal arranged in a vehicle, or a portable terminal. The infrastructure of a radio network UTRAN comprises radio network subsystems RNS, i.e. base transceiver station systems. A radio network subsystem RNS comprises a radio network controller RNC, i.e. a base station controller, and at least one node B, i.e. base transceiver station, under its control.

The base transceiver station B has a multiplexer 114, transceivers 116 and a control unit 118 which controls the operation of the transceivers 116 and the multiplexer 114. With the multiplexer 114, the traffic and control channels used by several transceivers 116 are placed in the transmission link lub.

The transceivers 116 of the base transceiver station B are connected to an antenna unit 120 which implements a bi-directional radio link Uu to user equipment UE. The structure of the frames to be transmitted over the bi-directional radio link Uu is clearly specified.

The radio network controller RNC comprises a group switching field 110 and control unit 112. The group switching field 110 is used to connect speech and data and to connect signalling circuits. The base station system formed by the base transceiver station B and the radio network controller RNC also comprises a transcoder 108. Work distribution between the radio network controller RNC and the base transceiver station B as well as their physical structure can vary depending on implementation. Typically, the base transceiver station B takes care of the radio path implementation as described above. The radio network controller RNC typically takes care of the following: management of radio resources, control of handover between cells, power adjustment, timing and synchronization, paging the user equipment.

The transcoder 108 is usually located as close as possible to a mobile switching centre 106, because speech can then be transmitted in mobile telephone system format between the transcoder 108 and the radio network controller RNC saving transmission capacity. The transcoder 108 converts the different digital coding formats of speech used between the public switched telephone network and the mobile telephone network to be compatible with each other, for instance from the 64 kbit/s format of a public network to another (e.g. 13 kbit/s) format of a cellular network and vice versa. The hardware required is not described in detail herein, but it can be noted that other data than speech is not converted in transcoder 122. The control

unit 112 takes care of call control, mobility management, collection of statistics, and signalling.

Core network CN comprises an infrastructure belonging to a mobile telephone system and external to UTRAN. Figure 1B describes two of the components in a core network CN, i.e. a mobile switching centre 106 and a gateway mobile switching centre 104 which handles the connections of the mobile telephone system to the outside world, in this case, to the public switched telephone network 102.

Figure 5 shows an example of the structure of user equipment UE. The essential parts of user equipment UE are: interface 504 to the antenna 502 of the user equipment, transceiver 506, control part 510 of the user equipment, and interface 512 to the battery 514. The user interface usually comprises a display 500, keyboard 508, microphone 516, and loudspeaker 518.

Figure 2A describes the operation of a radio transmitter - radio receiver pair. Figure 2A describes a case of downlink where the radio transmitter is located in node B and the radio receiver in the user equipment UE.

The upper part of Figure 2A describes the essential functions of the radio transmitter. Various services located in the physical channel include speech, data, moving or still video picture, and control channels of the system which are processed in the control part 214 of the radio transmitter. The figure shows the processing of the control channel and data. Different services require different source coding means, for instance speech requires a speech codec. For clarity's sake, source coding means are not, however, described in Figure 2A.

Different channel coding is then performed for different channels in blocks 202A and 202B. Channel coding includes, for instance, different block codes, an example of which is cyclic redundancy check (CRC). In addition, convolution coding and its various modifications, such as punctured convolution coding or turbo coding, are typically used.

When the different channels have been channel-coded, they are interleaved in an interleaver 204A, 204B. The purpose of interleaving is to facilitate error correction. In interleaving, the bits of different services are mixed in a certain manner together, in which case a momentary fade in the radio path does not necessarily make the transmitted information



unidentifiable. The interleaved bits are then spread with a spreading code, scrambled with a scrambling code and modulated in block 206A, 206B, the operation of which is described in greater detail in Figure 2B. Individual signals are combined in block 208 to be transmitted through one transmitter.

5           Finally, the combined signal is forwarded to radio frequency parts 210 which can comprise different power amplifiers and filters restricting bandwidth. The analogous radio signal is then transmitted through an antenna 212 to radio path Uu.

10           The lower part of Figure 2A describes the essential functions of the radio receiver. The radio receiver is typically a RAKE receiver. An analogous radio frequency signal is received from the radio path Uu with an antenna 234. The signal is forwarded to radio frequency parts 232 comprising a filter which prevents all frequencies outside the desired bandwidth. After this, the signal is converted in a demodulator 230 to an intermediate frequency or directly to a  
15           base band, and the thus converted signal is then sampled and quantized.

          As the signal in question is a multipath propagated signal, the aim is to combine the signal components that propagated via different paths in block 228 which comprises several RAKE fingers of prior art. The signal components received at different time delays by the RAKE fingers are searched for by  
20           correlating the received signal with the spreading codes used and delayed by predefined time delays. When the time delays of the signal components have been found, the signal components belonging to the same signal are combined. At the same time, the spreading of the signal components is removed by multiplying the signal by the spreading code of the physical  
25           channel. The interleaving of the received physical channel is then removed in deinterleaving means 226.

          The deinterleaved physical channel is then distributed to the data streams of various channels in a demultiplexer 224. The channels are directed each to its own channel decoding block 222A, 222B where the channel  
30           coding, for instance block coding or convolution coding, used in transmission is decoded. Convolution coding is preferably decoded with a Viterbi decoder. Each transmitted channel 220A, 220B can then be forwarded to a required further processing, for instance data 220 is forwarded to a computer 122 connected to the user equipment UE. The control channels of the system are  
35           forwarded to the control part 236 of the radio receiver.

Figure 2B describes in greater detail the spreading of a channel with a spreading code and its modulation. In the figure, the bit stream of the channel arrives from the left to block S/P in which each two-bit sequence is converted from serial mode to parallel mode, i.e. one bit is forwarded to the I branch of the signal and the second bit to the Q branch. Then the I and Q branches of the signal are multiplied by the same spreading code  $C_{ch}$ , in which case the relatively narrowband information is spread on a wide frequency band. Each link Uu has its own spreading code by which the receiver identifies transmissions meant for it. The signal is then scrambled by multiplying it by a scrambling code  $C_{scramb}$  which is different for each transmitter. The pulse format of the obtained signal is filtered with a filter  $p(t)$ . Finally, the signal is modulated to a radio frequency carrier by multiplying its different branches offset by 90 degrees from each other, the thus obtained branches are combined into one carrier which is ready to be transmitted to the radio path Uu apart from possible filtering and power amplifications. The described modulation method is QPSK (Quadrature Phase Shift Keying).

Figure 4A describes different spreading codes. Each point 400 represents one possible spreading code. The vertical dashed lines illustrate different spreading factors  $SF=1$ ,  $SF=2$ ,  $SF=4$ ,  $SF=8$ ,  $SF=16$ ,  $SF=32$ ,  $SF=64$ ,  $SF=128$ ,  $SF=256$ . The codes on each vertical dashed line are mutually orthogonal. It is thus possible to simultaneously use at most two hundred and fifty six different mutually orthogonal spreading codes. For instance in UMTS, when using a five-megahertz carrier at 4.096 megachips per second, a spreading factor of  $SF=256$  corresponds to a transmission rate of thirty two kilobits per second, and correspondingly the highest practical transmission rate is achieved with spreading factor  $SF=4$ , with which the data transmission rate is two thousand forty eight kilobits per second. The transmission rate in the channel varies thus step by step, 32, 64, 128, 256, 512, 1024, and 2048 kbit/s, while the spreading factor changes correspondingly, 256, 128, 64, 32, 16, 8, and 4. The data transmission rate available to the user depends on the channel coding used. For instance, when using 1/3 convolution coding, the data transmission rate of the user is approximately one third of the data transmission rate of the channel. The spreading factor indicates the length of the spreading code. For instance, the spreading code corresponding to spreading factor  $SF=1$  is (1). Spreading factor  $SF=2$  has two mutually orthogonal spreading codes (1,1) and (1,-1). Further, spreading code  $SF=4$

has four mutually orthogonal spreading codes: under the higher-level spreading code (1,1), there are spreading codes (1,1,1,1) and (1,1,-1,-1), and under the second higher-level spreading code (1,-1), there are spreading codes (1,-1,1,-1) and (1,-1,-1,1). The formation of spreading codes is thus continued towards the lower levels of the code tree. The spreading codes of a certain level are always mutually orthogonal. Similarly, a spreading code of a certain level is orthogonal with all lower-level spreading codes derived from another spreading code on the same level.

With reference to Figure 3, an example will be described as to what kind of frame structure can be used in a physical channel. Frames 340A, 340B, 340C, 340D are numbered sequentially from one to seventy two and they form a 720-millisecond long super frame. The length of one frame 340C is 10 milliseconds. Frame 340C is divided into sixteen slots 330A, 330B, 330C, 330D. The length of one slot 330C is 0.625 milliseconds. One slot 330C typically corresponds to one power adjustment period during which power is adjusted one decibel up or down, for instance.

Physical channels are divided into two different types: dedicated physical data channels (DPDCH) 310 and dedicated physical control channels (DPCCH) 312. Dedicated physical data channels 310 are used to transmit data 306 which is generated on the second layer and above of OSI (Open Systems Interconnection), i.e. closest to the dedicated traffic channels. Dedicated physical control channels 312 transmit control information generated on the first layer of OSI. Control information comprises pilot bits 300 used in channel estimation, transmit power control commands (TPC) 302, and optionally a transport format indicator (TFI) 304. The transport format indicator 304 indicates to the receiver the transmission rate used for each dedicated physical data channel of the uplink at a given time.

As shown in Figure 3, the dedicated physical data channels 310 and the dedicated physical control channels 312 on the downlink are time-multiplexed to the same slot 330C. However, on the uplink, the channels in question are transmitted parallel so that they are IQ/code-multiplexed (I=in-phase, Q=quadrature) to each frame 340C and transmitted using dual-channel QPSK modulation (dual-channel quadrature phase-shift keying modulation). When additional dedicated physical data channels 310 need to be transmitted, they are code-multiplexed to the I or Q branch of the first channel pair.

If necessary, an associated control channel can be multiplexed to a dedicated physical data channel, in which associated control channel the control data of the second and higher layers is transmitted, e.g. update data on active sets and adjustment of signal/interference target of the outer power control loop. This multiplexing causes a problem with capacity as described in the beginning.

When using spreading factor SF=256, for instance, there are ten symbols available for use, i.e. twenty bits for slot 330C. This makes 320 bits per frame. The use of these bits is distributed as shown in table 1, for instance.

Content	Length
DPCCH: PILOT	32 symbols = 64 bits
DPCCH: TPC	8 symbols = 16 bits
DPCCH: TFI	8 symbols = 16 bits
DPDCH: DATA	112 symbols = 224 bits

Table 1

Thus there are 224 bits left for user data. For instance, to transmit speech data to a normal speech codec at eight kilobits per second, 80 of the above bits are needed for data, 16 for cyclic redundancy check and 8 as tail bits, i.e. altogether 104 bits. The coding ratio obtained for the convolution coding to be used is  $104/224 = 0.46$ , and this does not yet include the approximately twenty bits needed by the associated control channel. The convolution coding to be used is thus already worse than 1/2 convolution coding. In such a channel, it is difficult to transmit the bits needed by the associated control channel, because the amount of channel coding is quite small and because it is necessary to use puncturing, i.e. elimination coding.

The situation becomes even worse, if it is necessary to transmit speech data to an enhanced speech codec, i.e. at a rate of 12.2 kbit/s. Then the coding ratio is only 0.60 (= 224 data bits + 16 CRC bits + 8 tail bits divided by 448).

The method of the invention for transmitting data from the radio network subsystem RNS over the radio link Uu to the user equipment UE can be described with the flowcharts in Figures 6A and 6B. The execution of the

method for an individual radio frame is started in block 600.

In blocks 604 and 606, the radio network subsystem RNS transmits a dedicated physical channel to the user equipment UE. As described above, the dedicated physical channel comprises a dedicated physical control  
5 channel and a dedicated physical data channel. As also described above, the dedicated physical channel is formed by frames to be transmitted to the radio link Uu.

In blocks 608 and 610, the radio network subsystem RNS spreads each channel with a spreading code during transmission. The length of the  
10 spreading code, i.e. spreading factor, determines the transmission rate, and a spreading code to be used in normal situation is reserved for the radio link Uu. The spreading factor of this normal spreading code can be 256, for instance.

Block 602 describes the basic idea of the invention, i.e. that in a special situation, at least one frame of a dedicated physical data channel is  
15 spread with a shared spreading code. The shared spreading code in question is shorter than the spreading code used in normal situations. In addition, the shared spreading code in question is shared by time division between the dedicated physical data channels of at least two different the radio links Uu. The spreading factor of the spreading code used in special situations can be  
20 128, for instance.

Figure 6B shows in greater detail the operation executed in block 602 of Figure 6A. The execution of the sub-block is started from block 620. Then, in block 622, a check is made to see if this is a special situation, i.e. is  
25 more than the usual amount of data transmission capacity needed for the dedicated physical data channel. If the need for data transmission capacity is as usual, i.e. it can be satisfied with the spreading code used in normal situations, execution continues from block 624.

In block 624, a check is made to see if a normal spreading code has already been allocated to the radio link Uu in question. If a code has not  
30 been allocated, execution continues from block 628 where a code is allocated and it is used to spread the frame being processed. If a code has already been allocated, execution continues from block 630 where the allocated spreading code is used to spread the frame.

If the need for data transmission capacity was higher than usual in  
35 block 622, execution is continued from block 626. In block 626, a check is made to see if any one of the already allocated shared spreading codes has

any free capacity. If none of the shared spreading codes have any free capacity, a new shared spreading code is selected in block 632 with a spreading factor smaller than that of the normally used spreading code, and the selected shared spreading code is used to spread the frame being processed. If one of the shared spreading codes has free capacity, the shared spreading code in question is used in block 634 to spread the frame being processed.

In the method, "normal situation" refers to a situation in which the spreading code allocated for the radio link can be used. Correspondingly, a "special situation" is one in which the data transmission capacity of the spreading code allocated for the radio link is not enough to transmit the required data. The spreading factor of a spreading code used in normal situations can be 256, for instance, and the spreading factor of a spreading code use in special situations 128, for instance. These numerical values are only examples, i.e. other kind of value combinations are also possible.

A special situation can be caused by the situation described above, in which an associated control channel is needed to be multiplexed to a dedicated physical data channel. Another example of a special situation is when the user equipment UE functions in slotted mode. In such a case, the user equipment UE measures the received power of other frequencies of adjacent base transceiver stations B for part of the duration of the radio frame transmitted normally by the radio network subsystem RNS. Such cells operating on different frequencies can occur in environments with both outdoor and indoor cells, for instance. Thus, the user equipment cannot receive the frame in question and the information it contains would be lost during normal operation. According to the invention, this is a special situation and during the rest of the duration of the frame, the radio network subsystem RNS transmits a shortened frame using a shared spreading code to spread it. Even though the frame is shortened, it can transmit the same quantity of data as in a normal frame thanks to the shared spreading code used. The data transmission capacity of a shared spreading code is higher than that of a normally used spreading code.

Let us then examine Figure 4B which shows how codes can be reserved from the code tree in Figure 4A to be used according to the method of the invention. It is assumed in Figure 4B that the spreading factor of a spreading code used in normal situations is  $SF=256$ , and the spreading factor

of a spreading code used in special situations is half of it, i.e. SF=128. The basic principle for sharing codes is that the spreading code reserved for the radio link Uu to be used in normal situations and the shared spreading code to be used in special situations reside on different levels and in different branches of the code tree. Generally, it can be said that if Y users share one spreading code, the spreading factor of which is SF=128, X spreading codes with spreading factor SF=256 remain for use:

$$X + 2(X/Y) = 256 \quad (1)$$

X can be obtained from Formula 1:

$$X = 256 / (1 + 2/Y) \quad (2)$$

Formula 2 can then be used to calculate values of X by substituting Y with different figures:

If Y=4, then X=170, i.e. if four users share one shared spreading code with spreading factor 128, then 170 spreading codes with spreading factor 256 remain free.

If Y=6, then X=192, i.e. if six users share one shared spreading code with spreading factor 128, then 192 spreading codes with spreading factor 256 remain free.

If Y=8, then X=204, i.e. if eight users share one shared spreading code with spreading factor 128, then 204 spreading codes with spreading factor 256 remain free.

The example of Figure 4B describes the middle alternative, i.e. it is assumed in the example that six radio links share the same shared spreading code.

Figure 4B illustrates normal spreading codes by means of indexes, which start with SF=256, i.e. spreading codes SF=256, CODE1, SD=256, CODE2, etc. These codes reserve the first 96 of the codes of spreading level SF=128. The shared spreading codes shared between six users are thus codes of spreading level SF=128: SF=128, CODE97, SF=128, CODE 98, etc. Altogether 192 codes of spreading level SF=256 and 32 shared codes of spreading level SF=128 are thus in use.

With the method of the invention, it is thus possible to support the

simultaneous use of as many as 192 orthogonal spreading codes, for instance to transmit speech or some other circuit-switched service, while fulfilling any requirements set by special situations. This provides a high increase of 50% in resources as opposed to prior art solutions in which only 128 orthogonal spreading codes can be simultaneously used without problems taking special situations into account.

Figures 7A and 7B are examined next. They illustrate how the spreading codes described in the example in Figure 4B are shared between radio links. In the example in Figure 7A, it is assumed that the frames of different radio links are not synchronized, i.e. their transmission times have not been synchronized with each other to transmit the frames at the same moment of time. Therefore, the radio link Uu receives a shared spreading code for use for a time period which is twice the length of the frame to be transmitted to the radio link Uu. Figure 7A shows in vertical direction the timing used for the radio links Uu of six user equipment UE1, UE2, UE3, UE4, UE5, UE6. The horizontal direction shows how ten-millisecond long radio frames numbered #1, #2, ..., #72 are transmitted consecutively to each user equipment. The lowest line segment shows the time slots of high data transmission capacity SLOT1, SLOT2, ..., SLOT6. One high data transmission slot is twice the length of a normal frame, i.e. twenty milliseconds. One after the other, each time slot now receives one high data transmission capacity slot for use. As six radio links share the spreading code of high data transmission capacity in question, each radio link can use the shared spreading code in question at hundred-millisecond intervals for twenty milliseconds at a time. In Figure 7A, a black frame marks the time slots of the radio link of each user equipment during which the user equipment in question can use the shared spreading code. In other words, user equipment UE1, for instance, can always use the first time slot SLOT1 of the shared spreading code. In which of its ten-millisecond frames the user equipment UE1 can use the shared spreading code is entirely dependent on the timing of the user equipment in question. The user equipment UE1 transmits frames #1, #13 using the shared spreading code. Correspondingly, the user equipment UE4, for instance, uses the fourth time slot SLOT4 of the shared spreading code and sends frames #7, #19, #31, #43, #55, and #67, for instance, using the shared spreading code, if necessary.

Figure 7B shows an enlarged detail of Figure 7A outlined in Figure



7A with a dashed line and marked with reference "FIG 7B". Figure 7B illustrates how three frames FRAME #6, FRAME #7, and FRAME #8 of the fourth user equipment UE4 are spread. In the normally transmitted frames FRAME #6 and FRAME #9, both the dedicated physical control channel and the dedicated physical data channel are spread using the spreading code, the spreading factor of which is  $SF=256$ , allocated to the link for normal situations. According to the invention, the dedicated physical data channel of the frame FRAME #7 is spread using the shared spreading code, the spreading factor of which is  $SF=128$ . There are two different possibilities for spreading the dedicated physical control channel of the frame FRAME #7: either the same shared spreading code is used as for spreading the dedicated physical data channel, or the spreading code for normal situations is used.

The example in Figure 7A illustrated a case in which frames of different radio links were not synchronized with each other. When the frames of different radio links Uu are synchronized with each other, each radio link Uu receives the shared spreading code for use for a time period which is the same length as the frame to be transmitted to the radio link Uu. In this case, each user equipment can use the shared spreading code at intervals of fifty milliseconds.

In a preferred embodiment, each radio link Uu receives the shared spreading code for use when necessary. In comparison with the example in Figure 7A, in which each radio link Uu receives the shared spreading code for use as frames agreed in advance by the radio network subsystem RNS and the user equipment UE, this provides the advantage that the shared code resource is not kept reserved in vain, but the disadvantage in this is that more signalling is required.

In a preferred embodiment, the dedicated physical control channel comprises a transport format indicator TFI which indicates the spreading code used to spread the dedicated physical data channel. This can be implemented in at least two different ways: 1) the transport format indicator in the received physical frame indicates the spreading code used to spread the dedicated physical data channel in the received frame, 2) the transport format indicator in the physical frame preceding the received physical frame indicates the spreading code used to spread the dedicated physical data channel in the received frame. In alternative 1, the signalling does not have a delay of ten milliseconds as is the case in alternative 2. On the other hand, alternative 2

does not require duplication of the parts removing the spreading in the receiver as is the case in alternative 1.

The method of the invention can also be used in a situation where the user equipment UE is performing a soft handover. In a soft handover, at least two different base transceiver stations B transmit to the user equipment UE a dedicated physical data channel using a shared spreading code of equal length for spreading so that the user equipment UE receives the transmissions in question substantially at the same moment. The shared spreading code used is selected independently for each base transceiver station B, i.e. it does not have to be the same as long as the length of the spreading code used is the same, i.e. they have the same spreading factor. Timing need not be the same and it is, in practice, enough that for instance the symbols transmitted via different radio paths to the user equipment UE overlap partly. For example, when using a five-megahertz carrier at 4.096 megachips per second, it is possible to send 160 symbols per one ten-millisecond frame channel-coded with a spreading code, the spreading factor of which is 256. Thus, the chips of symbols corresponding to each other need not be exactly on top of each other, but an offset of 50 to 100 chips, for instance, is allowed. The offset can also be larger, but then the processing required is more complex.

The invention is preferably implemented by means of software. The processing required in the radio network subsystem necessitates changes in the protocol processing software and in the control of transmitter operation, in particular the processing of spreading codes. Correspondingly, it is necessary to make changes in the protocol processing software and in the control of receiver operation, in particular the processing of spreading codes, of the user equipment.

Even though the invention has been explained in the above with reference to examples in accordance with the accompanying drawings, it is obvious that the invention is not restricted to them but can be modified in many ways within the scope of the inventive idea disclosed in the attached claims.

## CLAIMS

1. A method for transmitting data from a radio network subsystem (RNS) over a radio link (Uu) to user equipment (UE) in a mobile telephone system, which comprises:

5           - (604, 606) the radio network subsystem (RNS) transmits a dedicated physical channel to the user equipment (UE), which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and the dedicated physical channel is formed by frames to be transmitted to the radio link (Uu);

10           - (608, 610) during transmission, the radio network subsystem (RNS) spreads each channel with a spreading code, the length of which spreading code, i.e. spreading factor, determines the data transmission rate, and a spreading code to be used in normal situations is reserved for the radio link (Uu),

15           **characterized** in that (602) in a special situation at least one frame of the dedicated physical data channel is spread with a shared spreading code, which shared spreading code is shorter than the spreading code used in normal situations, and the shared spreading code in question is shared by time division between the dedicated physical data channels of at  
20           least two different radio links (Uu).

2. A method as claimed in claim 1, **characterized** in that an associated control channel is multiplexed to the dedicated physical data channel in special situations.

25           3. A method as claimed in claim 1, **characterized** in that in special situations the user equipment (UE) functions in slotted mode, in which the user equipment (UE) measures the received power of other frequencies of adjacent base transceiver stations (B) for part of the duration of the frame transmitted normally by the radio network subsystem (RNS), and during the rest of the duration of the frame, the radio network subsystem (RNS) transmits  
30           a shortened frame using a shared spreading code to spread it.

35           4. A method as claimed in claim 1, **characterized** in that when the frames of different radio links (Uu) are not synchronized with each other, each radio link (Uu) receives a shared spreading code for use for a time period which is twice the length of the frame to be transmitted to the radio link (Uu).

5. A method as claimed in claim 1, **characterized** in that when the frames of different radio links (Uu) are synchronized with each other, each radio link (Uu) receives a shared spreading code for use for a time period which is the same length as the frame to be transmitted to the radio link Uu.

5       6. A method as claimed in claim 1, **characterized** in that the dedicated physical control channel is spread with a shared spreading code.

10       7. A method as claimed in claim 1, **characterized** in that each radio link (Uu) receives a shared spreading code for use as frames agreed in advance by the radio network subsystem (RNS) and the user equipment (UE).

8. A method as claimed in claim 1, **characterized** in that each radio link (Uu) receives a shared spreading code for use when necessary.

15       9. A method as claimed in claim 1, **characterized** in that the dedicated physical control channel comprises a transport format indicator which indicates the spreading code used to spread the dedicated physical data channel.

20       10. A method as claimed in claim 9, **characterized** in that the transport format indicator in the received physical frame indicates the spreading code used to spread the dedicated physical data channel in the received frame.

25       11. A method as claimed in claim 9, **characterized** in that the transport format indicator in the physical frame preceding the received physical frame indicates the spreading code used to spread the dedicated physical data channel in the received frame.

30       12. A method as claimed in claim 1, **characterized** in that the spreading codes are arranged into a code tree in such a manner that the first level of the code tree root comprises a one-bit spreading code, the second level comprises two branches with mutually orthogonal two-bit spreading codes, the third level comprises four branches with mutually orthogonal four-bit spreading codes, the fourth level comprises eight branches with mutually orthogonal eight-bit spreading codes, the fifth level comprises sixteen branches with mutually orthogonal sixteen-bit spreading codes, the sixth level  
35       comprises thirty two branches with mutually orthogonal thirty-two-bit spreading codes, the seventh level comprises sixty four branches with mutually

orthogonal sixty-four-bit spreading codes, the eight level comprises one hundred and twenty eight branches with mutually orthogonal 128-bit spreading codes, the ninth level comprises two hundred and fifty six branches with mutually orthogonal 256-bit spreading codes, and an unambiguous method to refer to a spreading code has been agreed on by the radio network subsystem (RNS) and the user equipment (UE).

13. A method as claimed in claim 12, **characterized** in that the transmission rate is altered by changing the length of the spreading code used to spread a frame, i.e. by moving from one level to another in the code tree.

14. A method as claimed in claim 12, **characterized** in that the spreading code reserved for the radio link (Uu) to be used in normal situations and the shared spreading code to be used in special situations reside on different levels and in different branches of the code tree.

15. A method as claimed in claim 1, **characterized** in that in a soft handover at least two different base transceiver stations (B) transmit to the user equipment (UE) a dedicated physical data channel using a shared spreading code of equal length for spreading so that the user equipment (UE) receives the transmissions in question substantially at the same moment.

16. A radio network subsystem (RNS) which is adapted:

- to transmit a dedicated physical channel over a radio link (Uu) to the user equipment (UE), which dedicated physical channel comprises a dedicated physical control channel and a dedicated physical data channel, and to form a dedicated physical channel from the frames to be transmitted to the radio link (Uu);

- to spread each channel with a spreading code during transmission, the length of which spreading code, i.e. spreading factor, determines the data transmission rate, and to reserve a spreading code to be used in normal situations for the radio link (Uu).

**characterized** in that the subsystem is adapted to spread in a special situation at least one frame of the dedicated physical data channel with a shared spreading code which is shorter than the spreading code used in normal situations, and to share the shared spreading code in question by time division between the dedicated physical data channels of at least two different radio links (Uu).

17. A radio network subsystem as claimed in claim 16, **characterized** in that in special situations the radio network subsystem (RNS) is adapted to multiplex an associated control channel to the dedicated physical data channel.

5 18. A radio network subsystem as claimed in claim 16, **characterized** in that in special situations the user equipment (UE) functions in slotted mode, in which the user equipment (UE) measures the received power of other frequencies of adjacent base transceiver stations (B) for part of the duration of the frame transmitted normally by the radio network  
10 subsystem (RNS), and during the rest of the duration of the frame, the radio network subsystem (RNS) is adapted to transmit a shortened frame using a shared spreading code to spread it.

19. A radio network subsystem as claimed in claim 16, **characterized** in that when the frames of different radio links (Uu) are  
15 not synchronized with each other, the radio network subsystem (RNS) is adapted to provide each radio link (Uu) with a shared spreading code for use for a time period which is twice the length of the frame to be transmitted to the radio link (Uu).

20. A radio network subsystem as claimed in claim 16, **characterized** in that when the frames of different radio links (Uu) are  
20 synchronized with each other, the radio network subsystem (RNS) is adapted to provide each radio link (Uu) with a shared spreading code for use for a time period which is the same length as the frame to be transmitted to the radio link Uu.

25 21. A radio network subsystem as claimed in claim 16, **characterized** in that the radio network subsystem (RNS) is adapted to spread a dedicated physical control channel with a shared spreading code.

22. A radio network subsystem as claimed in claim 16, **characterized** in that the radio network subsystem (RNS) is adapted to  
30 provide each radio link (Uu) with a shared spreading code as frames agreed in advance by the radio network subsystem (RNS) and the user equipment (UE).

23. A radio network subsystem as claimed in claim 16, **characterized** in that the radio network subsystem (RNS) is adapted to provide each radio link (Uu) with a shared spreading code when necessary.

35 24. A radio network subsystem as claimed in claim 16, **characterized** in that the radio network subsystem (RNS) is adapted to

place into the dedicated physical control channel a transport format indicator which indicates the spreading code used to spread the dedicated physical data channel.

25. A radio network subsystem as claimed in claim 24,  
5 **characterized** in that the radio network subsystem (RNS) is adapted to place into the transport format indicator of the physical frame to be transmitted the identification data of the spreading code used to spread the dedicated physical data channel in the frame to be transmitted.

26. A radio network subsystem as claimed in claim 24,  
10 **characterized** in that the radio network subsystem (RNS) is adapted to place into the transport format indicator of the physical frame preceding the physical frame to be transmitted the identification data of the spreading code used to spread the dedicated physical data channel in the frame to be transmitted.

15 27. A radio network subsystem as claimed in claim 16, **characterized** in that the spreading codes are arranged into a code tree in such a manner that the first level of the code tree root comprises a one-bit spreading code, the second level comprises two branches with mutually orthogonal two-bit spreading codes, the third level comprises four branches  
20 with mutually orthogonal four-bit spreading codes, the fourth level comprises eight branches with mutually orthogonal eight-bit spreading codes, the fifth level comprises sixteen branches with mutually orthogonal sixteen-bit spreading codes, the sixth level comprises thirty two branches with mutually orthogonal thirty-two-bit spreading codes, the seventh level comprises sixty  
25 four branches with mutually orthogonal sixty-four-bit spreading codes, the eighth level comprises one hundred and twenty eight branches with mutually orthogonal 128-bit spreading codes, the ninth level comprises two hundred and fifty six branches with mutually orthogonal 256-bit spreading codes, and an unambiguous method to refer to a spreading code has been agreed on by  
30 the radio network subsystem (RNS) and the user equipment (UE).

28. A radio network subsystem as claimed in claim 27, **characterized** in that the radio network subsystem (RNS) is adapted to alter the transmission rate by changing the length of the spreading code used to spread a frame, i.e. by moving from one level to another in the code tree.

35 29. A radio network subsystem as claimed in claim 27, **characterized** in that the radio network subsystem (RNS) is adapted to

reserve for the radio link (Uu) from different levels and branches of the code tree a spreading code for use in normal situations and a shared spreading code for special situations.

30. A radio network subsystem as claimed in claim 16,  
5 **characterized** in that in a soft handover, the radio network subsystem (RNS) is adapted to transmit a dedicated physical data channel to the user equipment (UE) through at least two different base transceiver stations (B) using a shared spreading code of equal length for spreading so that the user  
10 equipment (UE) receives the transmissions in question substantially at the same moment.

31. User equipment (UE) which is adapted:

- to receive a dedicated physical channel transmitted by the radio network subsystem (RNS) over a radio link (Uu), which dedicated physical channel comprises a dedicated physical control channel and a dedicated  
15 physical data channel, and to form a dedicated physical channel from the frames to be received from the radio link (Uu);

- to remove during reception the spreading of each channel with a spreading code, the length of which spreading code, i.e. spreading factor, determines the data transmission rate, and to use in normal situations the  
20 spreading code reserved for the radio link (Uu) for normal situations to remove the spreading,

**characterized** in that in special situations, the user equipment is adapted to remove the spreading of at least one frame of the dedicated physical data channel with a shared spreading code which is shorter  
25 than the spreading code used in normal situations and which is used by time division between the dedicated physical data channels of at least two different radio links (Uu).

32. User equipment as claimed in claim 31, **characterized** in that in special situations the user equipment (UE) is adapted to demultiplex  
30 an associated control channel from the physical data channel.

33. User equipment as claimed in claim 31, **characterized** in that in special situations the user equipment (UE) is adapted to function in slotted mode, in which the user equipment (UE) measures the received power of other frequencies of adjacent base transceiver stations (B) for part of the  
35 duration of the frame transmitted normally by the radio network subsystem (RNS), and during the rest of the duration of the frame, the user equipment



(UE) is adapted to receive a shortened frame transmitted by the radio network subsystem (RNS), and to use the shared spreading code to remove the spreading of the shortened frame in question.

5           34. User equipment as claimed in claim 31, **characterized** in that when the frames of different radio links (Uu) are not synchronized with each other, the user equipment (UE) is adapted to receive a shared spreading code for use for a time period which is twice the length of the frame to be received from the radio link (Uu).

10           35. User equipment as claimed in claim 31, **characterized** in that when the frames of different radio links (Uu) are synchronized with each other, the user equipment (UE) is adapted to receive a shared spreading code for use for a time period which is the same length as the frame to be received from the radio link Uu.

15           36. User equipment as claimed in claim 31, **characterized** in that the user equipment (UE) is adapted to remove the spreading of the dedicated physical control channel with the shared spreading code.

20           37. User equipment as claimed in claim 31, **characterized** in that the user equipment (UE) is adapted to agree with the radio network subsystem (RNS), in which earlier agreed frames will the shared spreading code be used in a radio link (Uu).

            38. User equipment as claimed in claim 31, **characterized** in that the user equipment (UE) is adapted to request from the radio network subsystem (RNS) a shared spreading code for use in a radio link (Uu), when necessary.

25           39. User equipment as claimed in claim 31, **characterized** in that the user equipment (UE) is adapted to read the spreading code used to spread the dedicated physical data channel from the transport format indicator in the dedicated physical control channel.

30           40. User equipment as claimed in claim 39, **characterized** in that the user equipment (UE) is adapted to read the identification data of the spreading code used to spread the dedicated physical data channel in the received frame from the transport format indicator in the received physical frame.

35           41. User equipment as claimed in claim 39, **characterized** in that the user equipment (UE) is adapted to read the identification data of the spreading code used to spread the dedicated physical data channel in the

received frame from the transport format indicator in the physical frame preceding the received physical frame.

42. User equipment as claimed in claim 31, **characterized** in that the spreading codes are arranged into a code tree in such a manner that  
5 the first level of the code tree root comprises a one-bit spreading code, the second level comprises two branches with mutually orthogonal two-bit spreading codes, the third level comprises four branches with mutually orthogonal four-bit spreading codes, the fourth level comprises eight branches with mutually orthogonal eight-bit spreading codes, the fifth level comprises  
10 sixteen branches with mutually orthogonal sixteen-bit spreading codes, the sixth level comprises thirty two branches with mutually orthogonal thirty-two-bit spreading codes, the seventh level comprises sixty four branches with mutually orthogonal sixty-four-bit spreading codes, the eighth level comprises one hundred and twenty eight branches with mutually orthogonal 128-bit  
15 spreading codes, the ninth level comprises two hundred and fifty six branches with mutually orthogonal 256-bit spreading codes, and an unambiguous method to refer to a spreading code has been agreed on by the radio network subsystem (RNS) and the user equipment (UE).

43. User equipment as claimed in claim 31, **characterized** in  
20 that in a soft handover, the user equipment (UE) is adapted to receive a dedicated physical data channel transmitted through at least two different base transceiver stations (B) substantially at the same moment, and to remove the spreading using a shared spreading code of equal length.

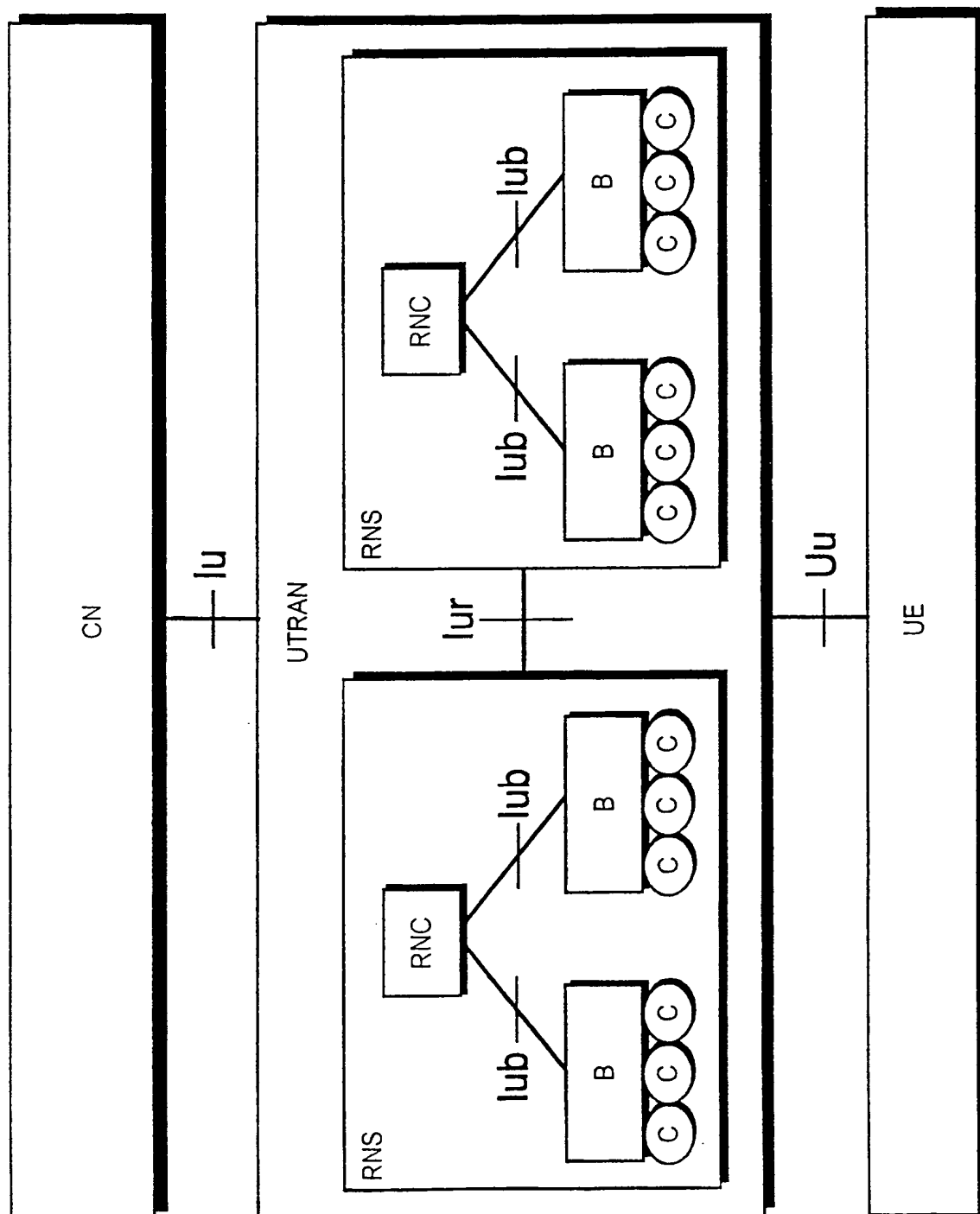


Fig 1A

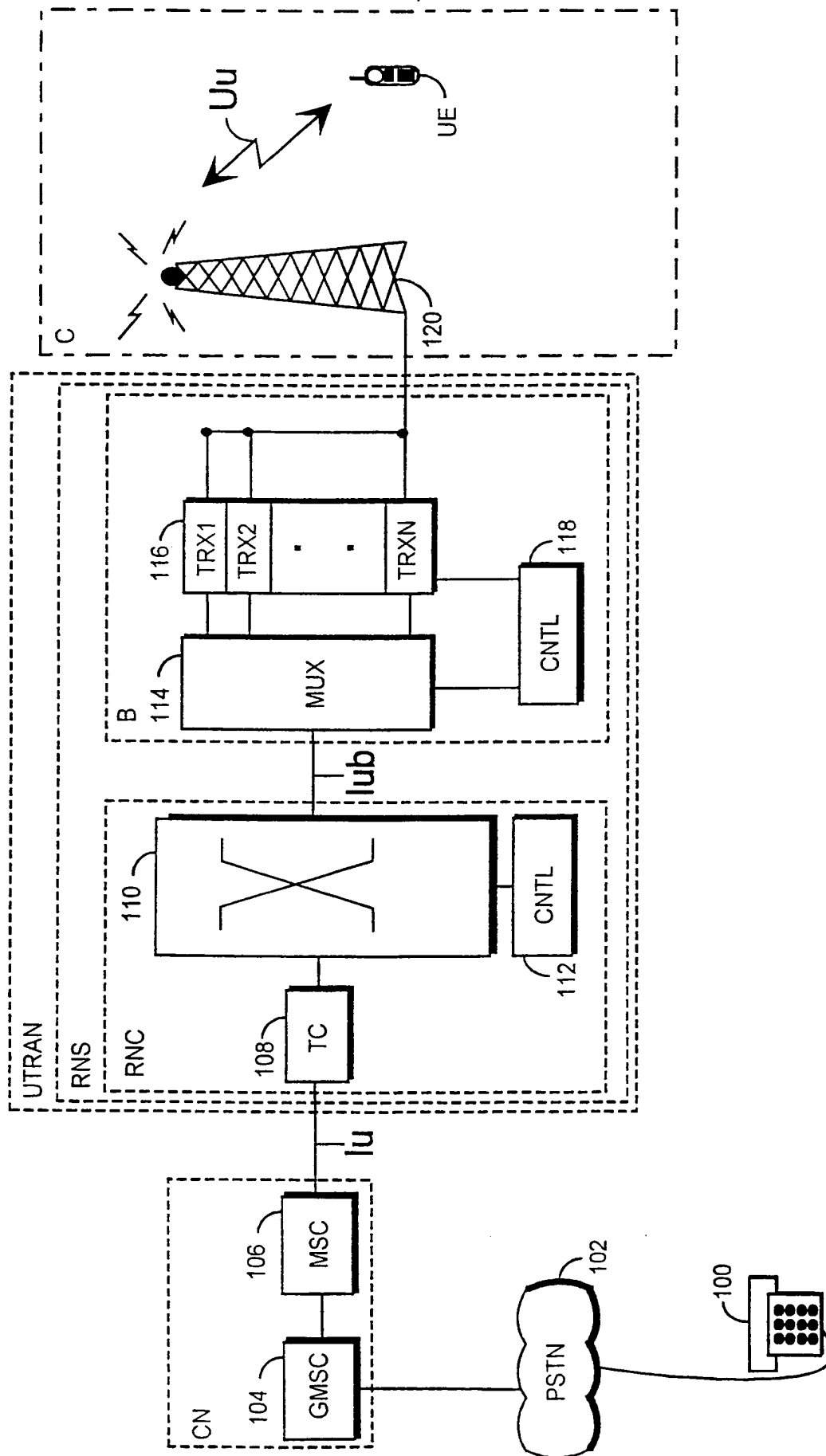


Fig 1B

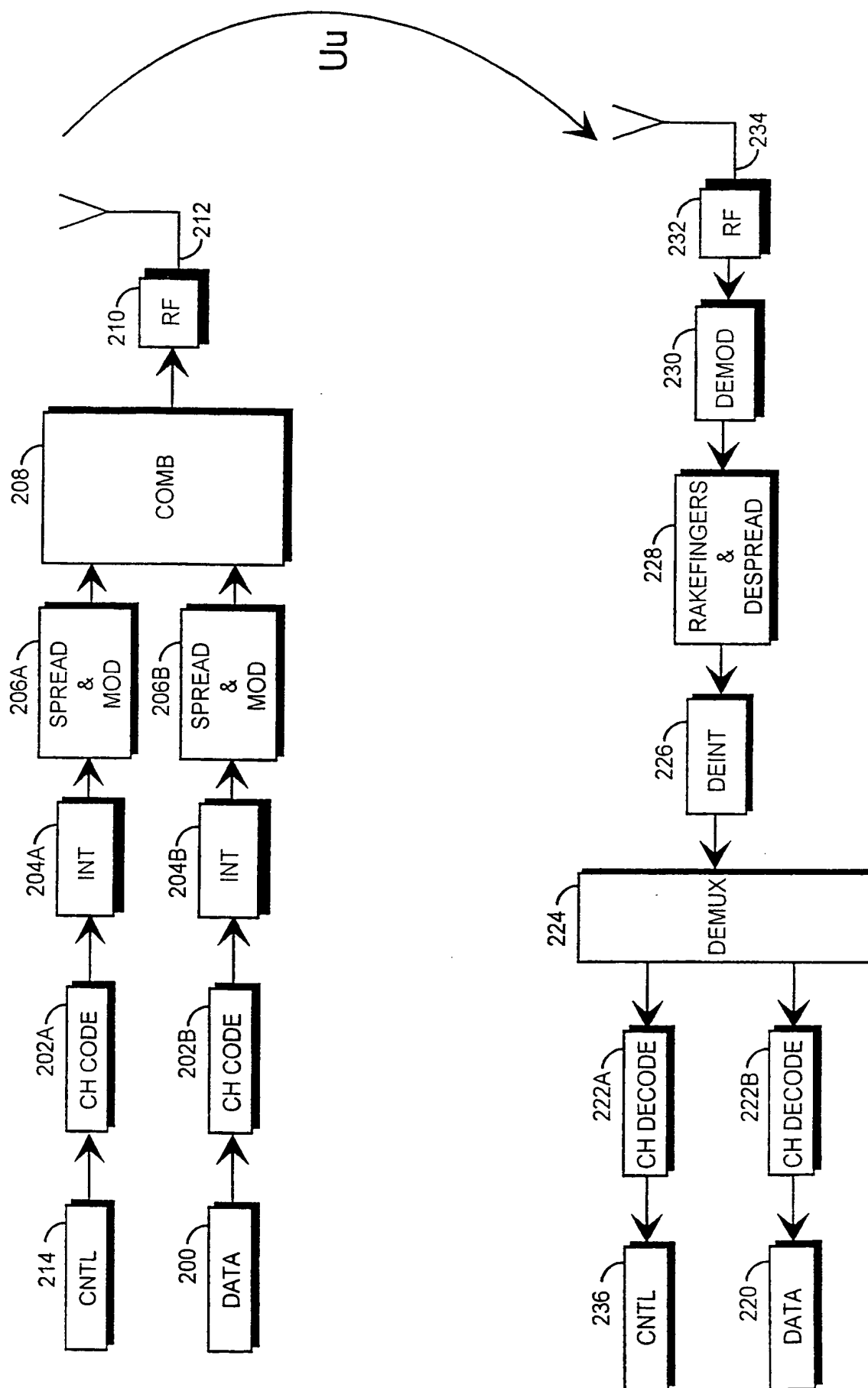


Fig 2A

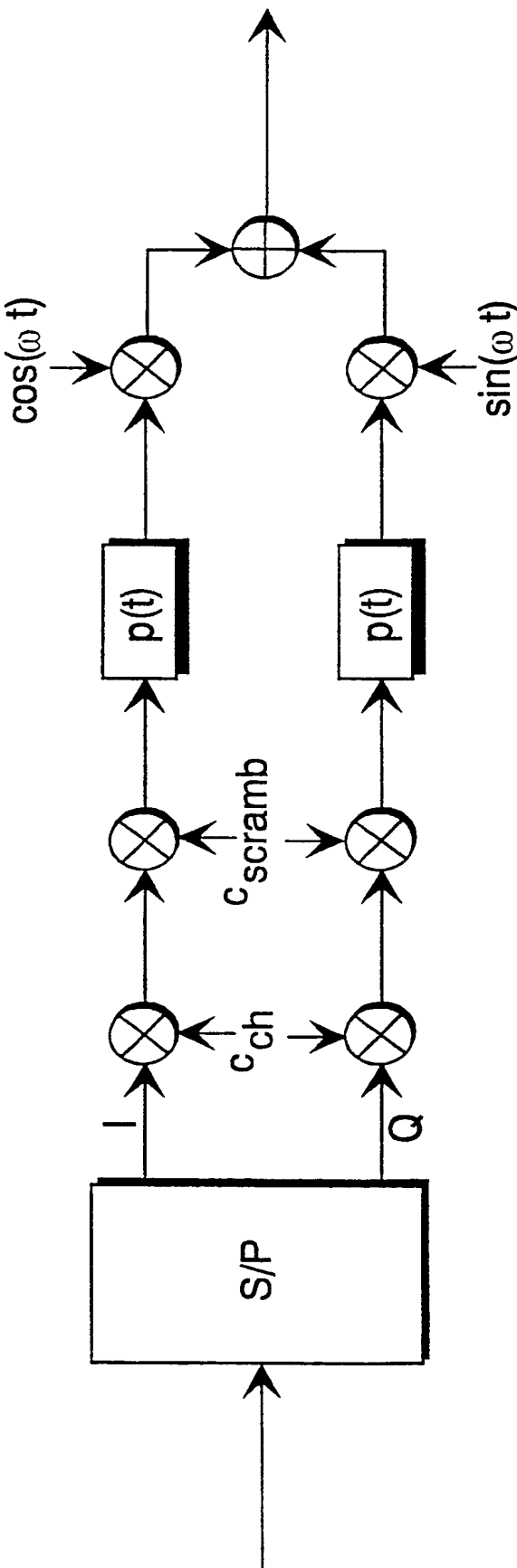


Fig 2B

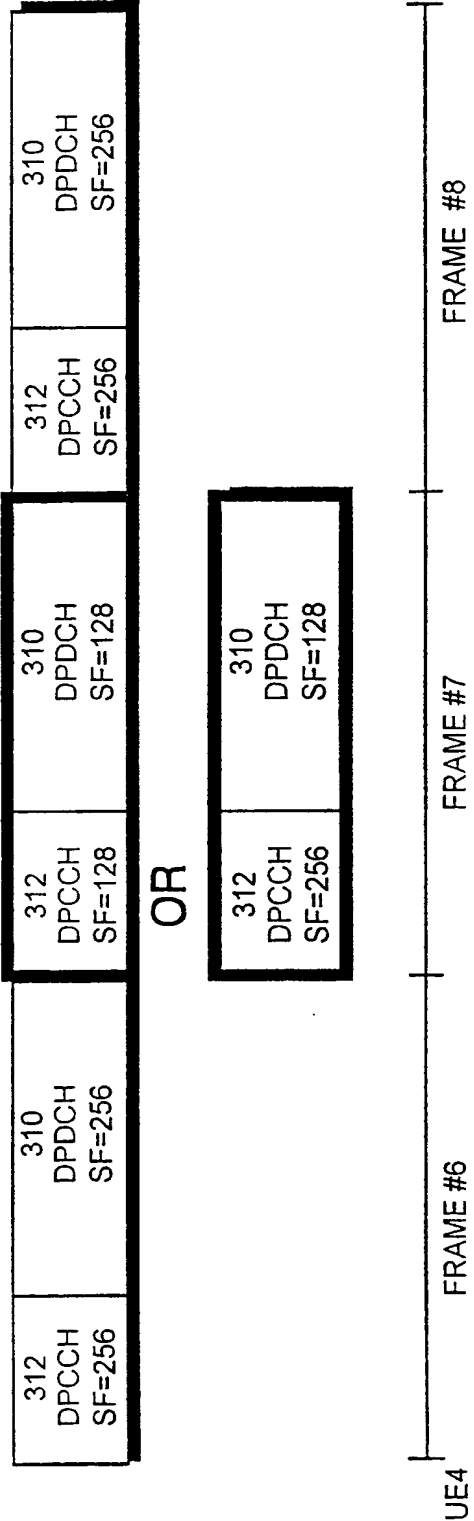


Fig 7B

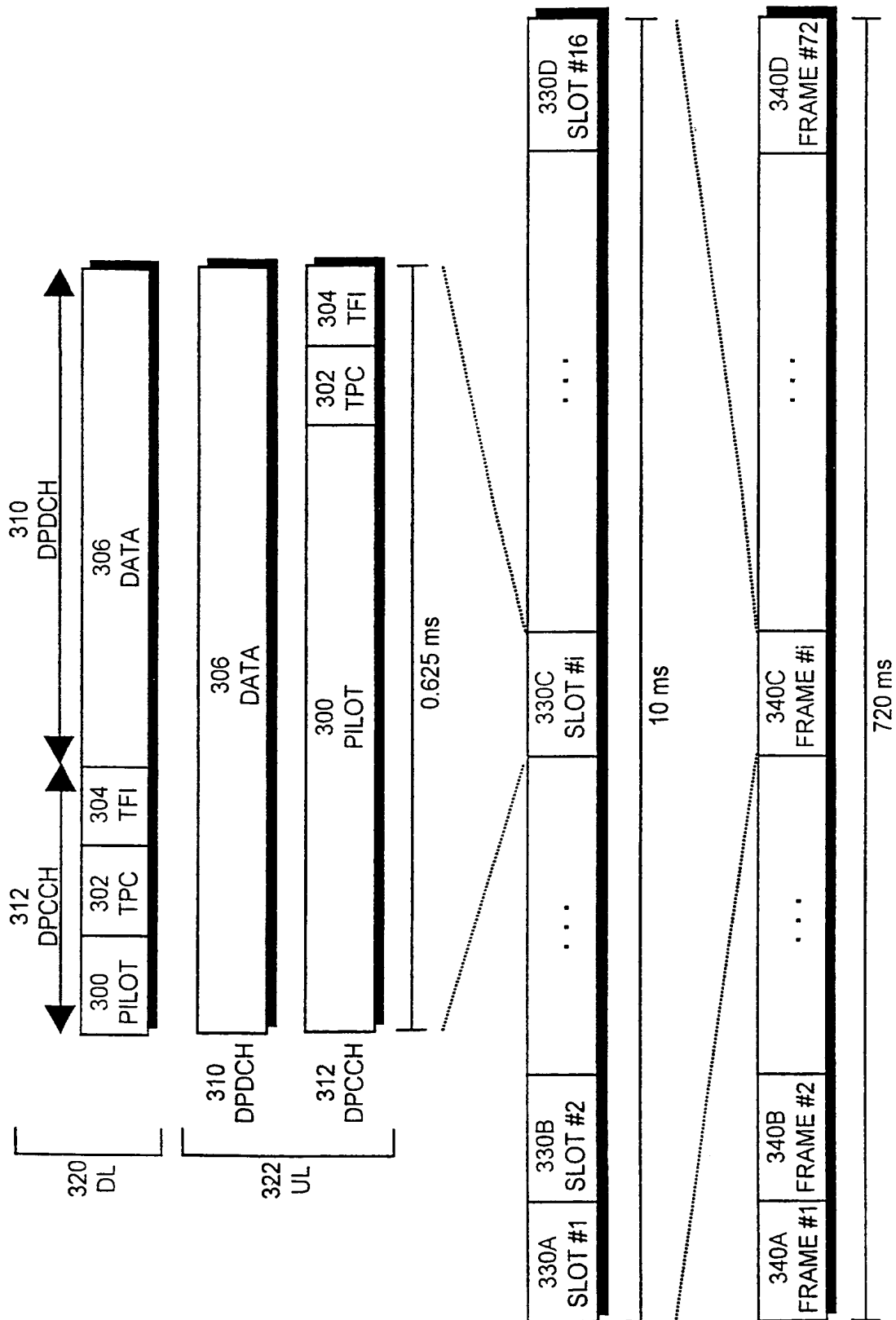


Fig 3

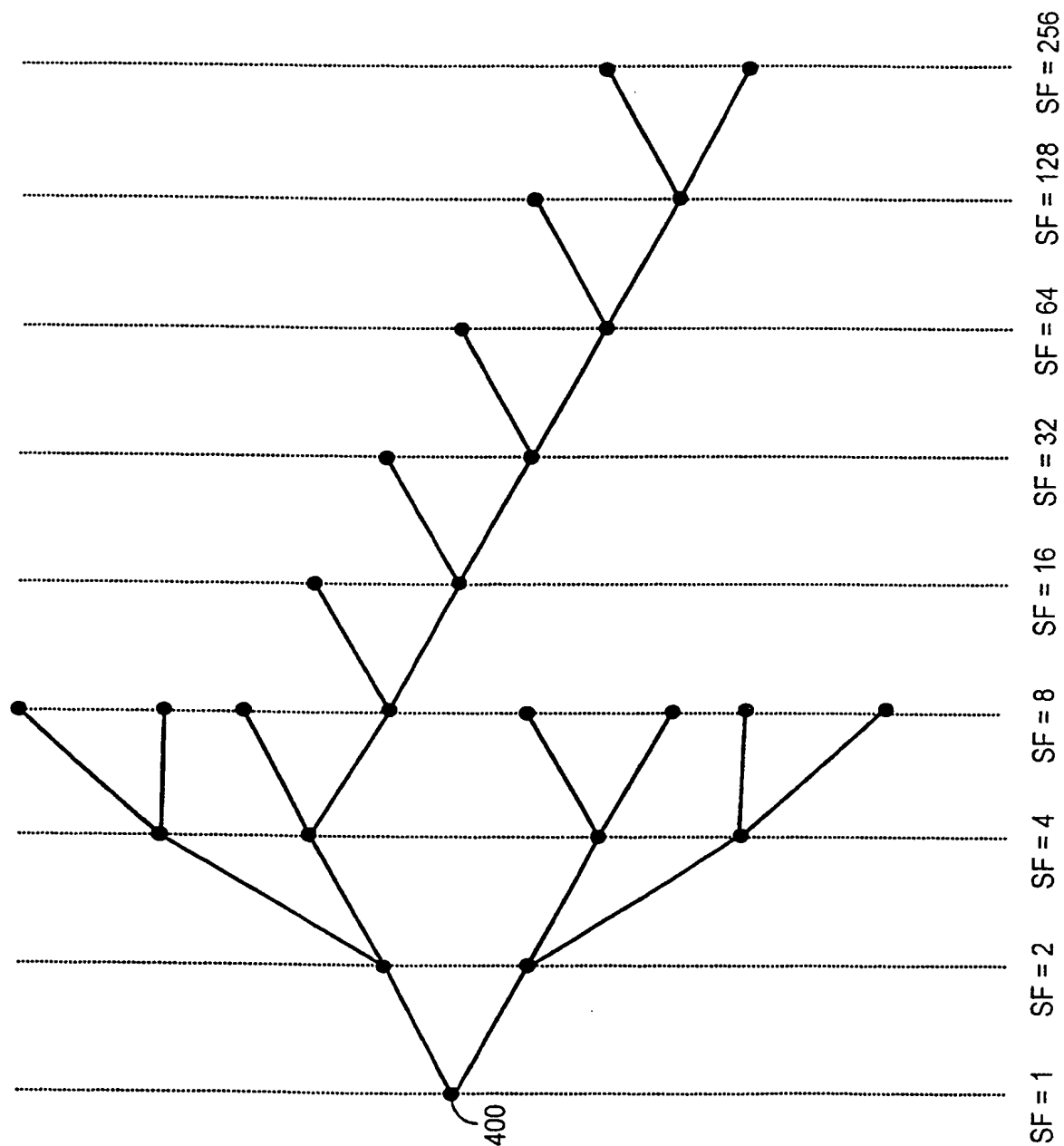


Fig 4A



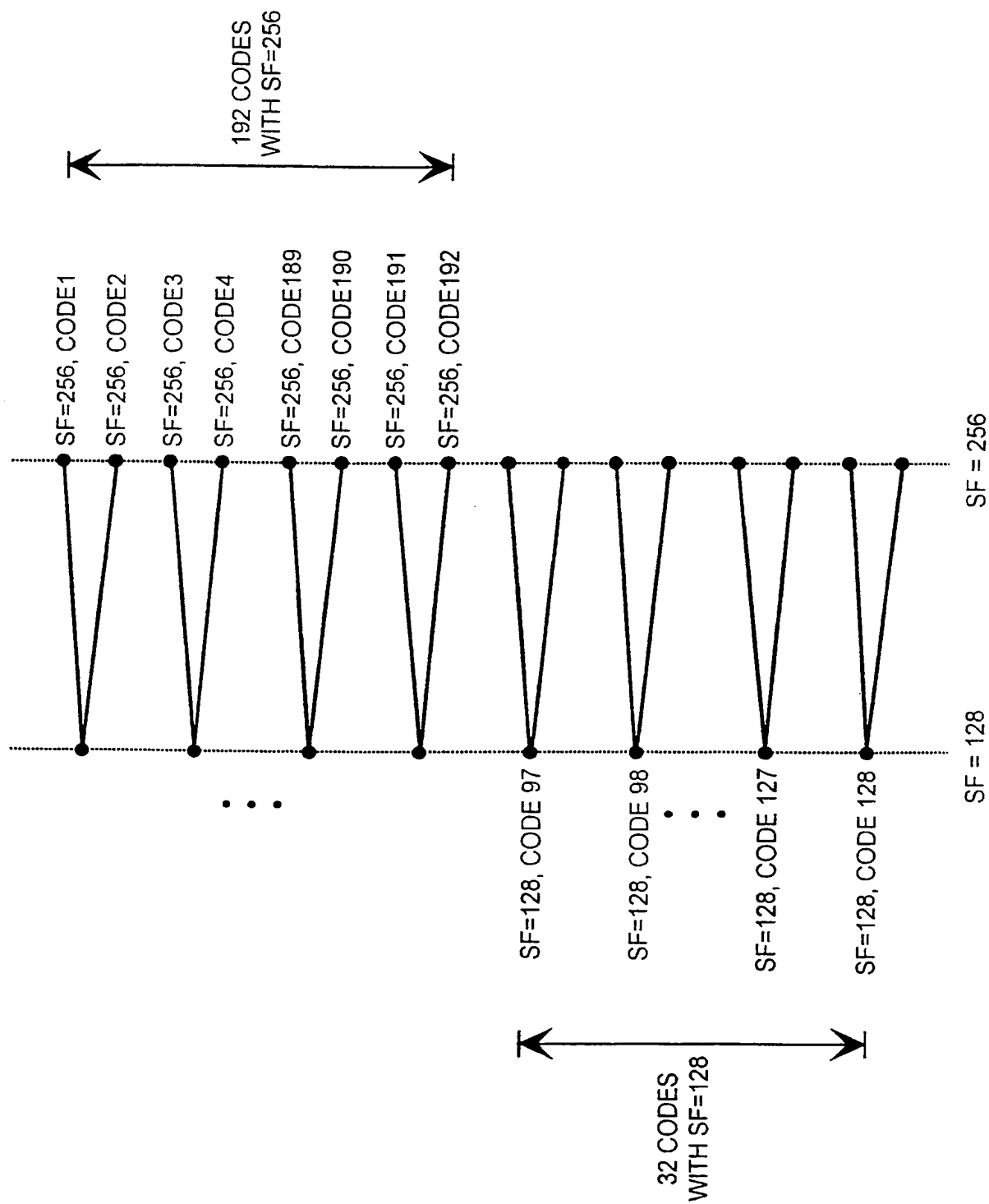


Fig 4B

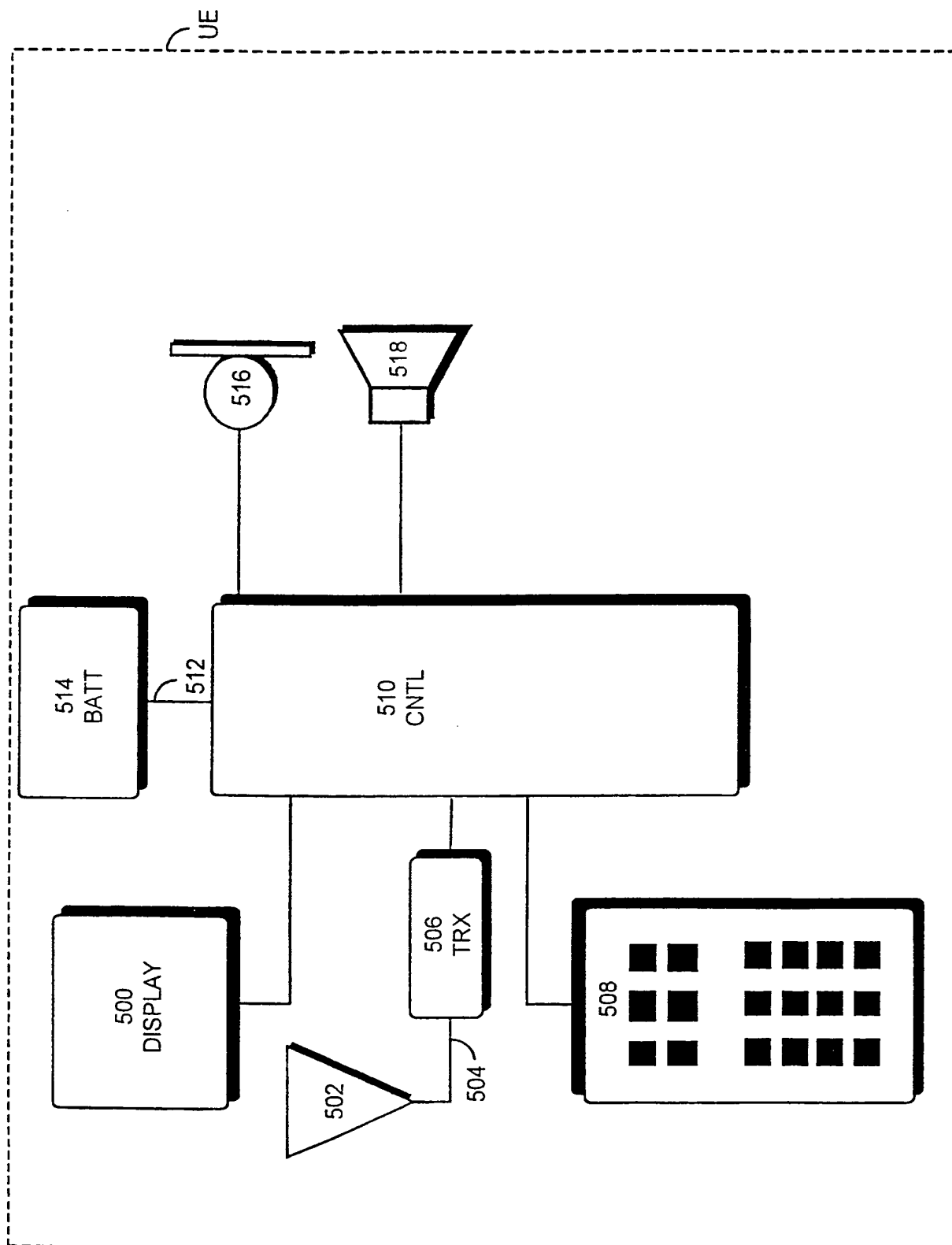


Fig 5

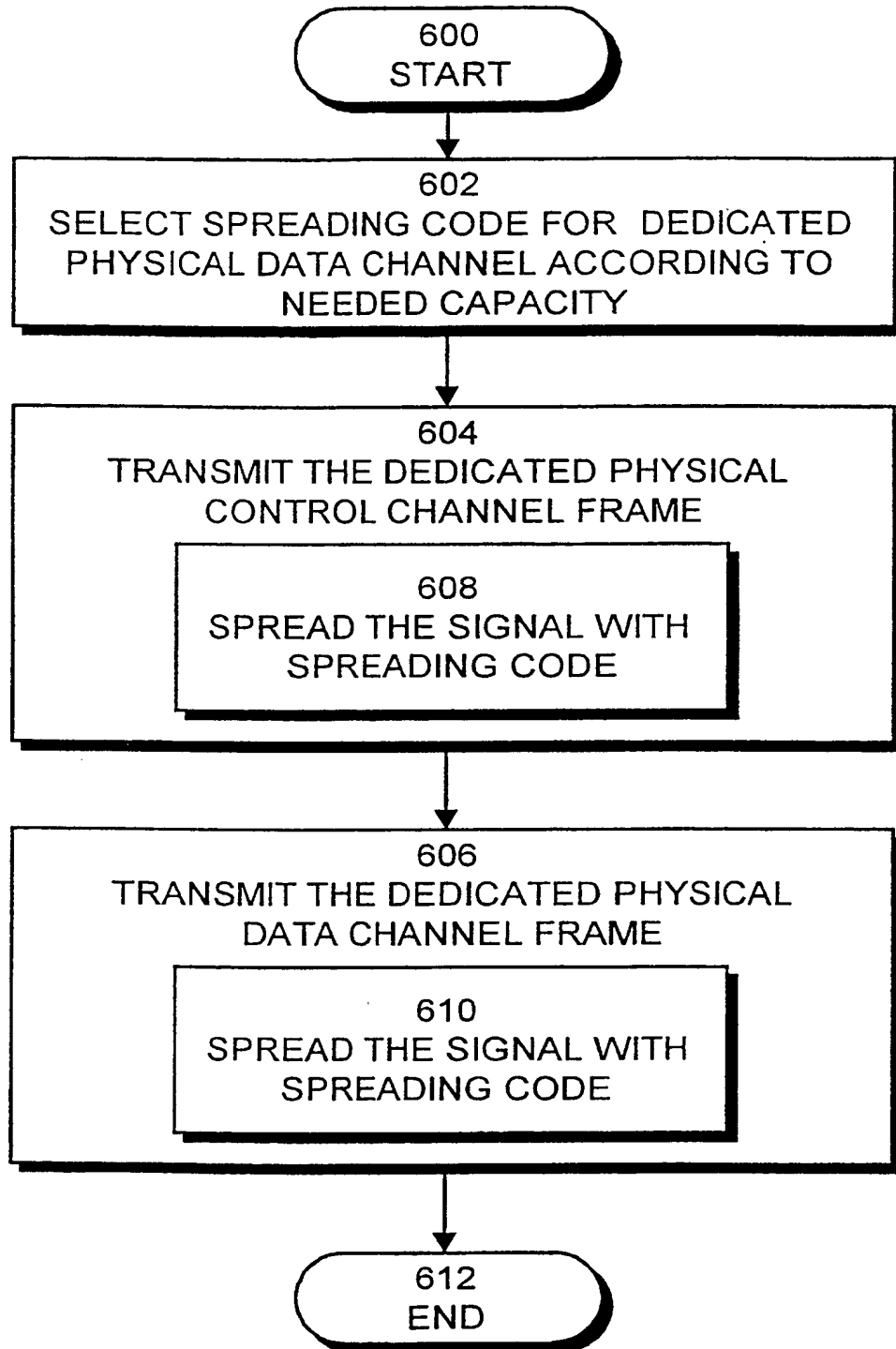


Fig 6A

10/11

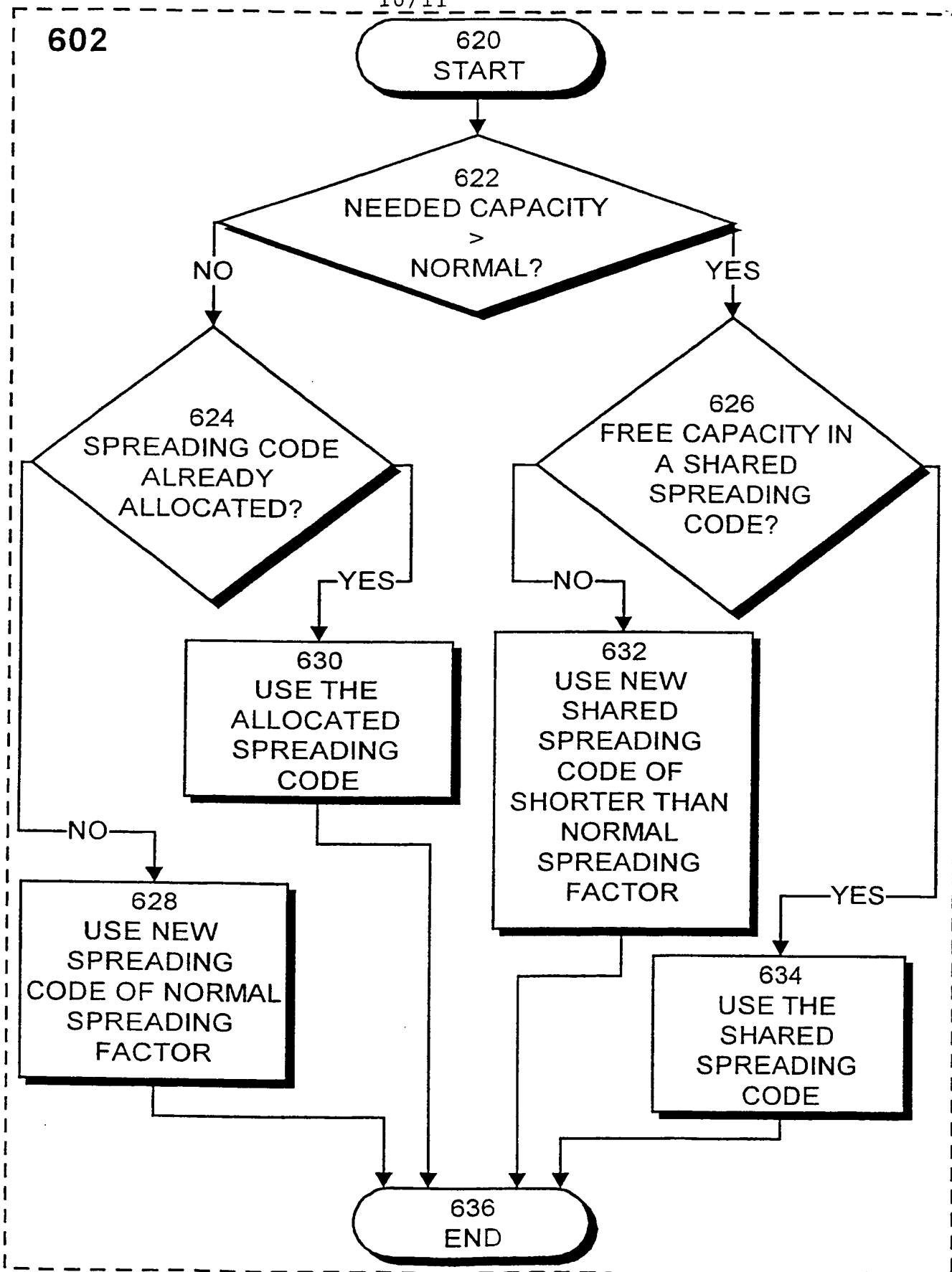


Fig 6B

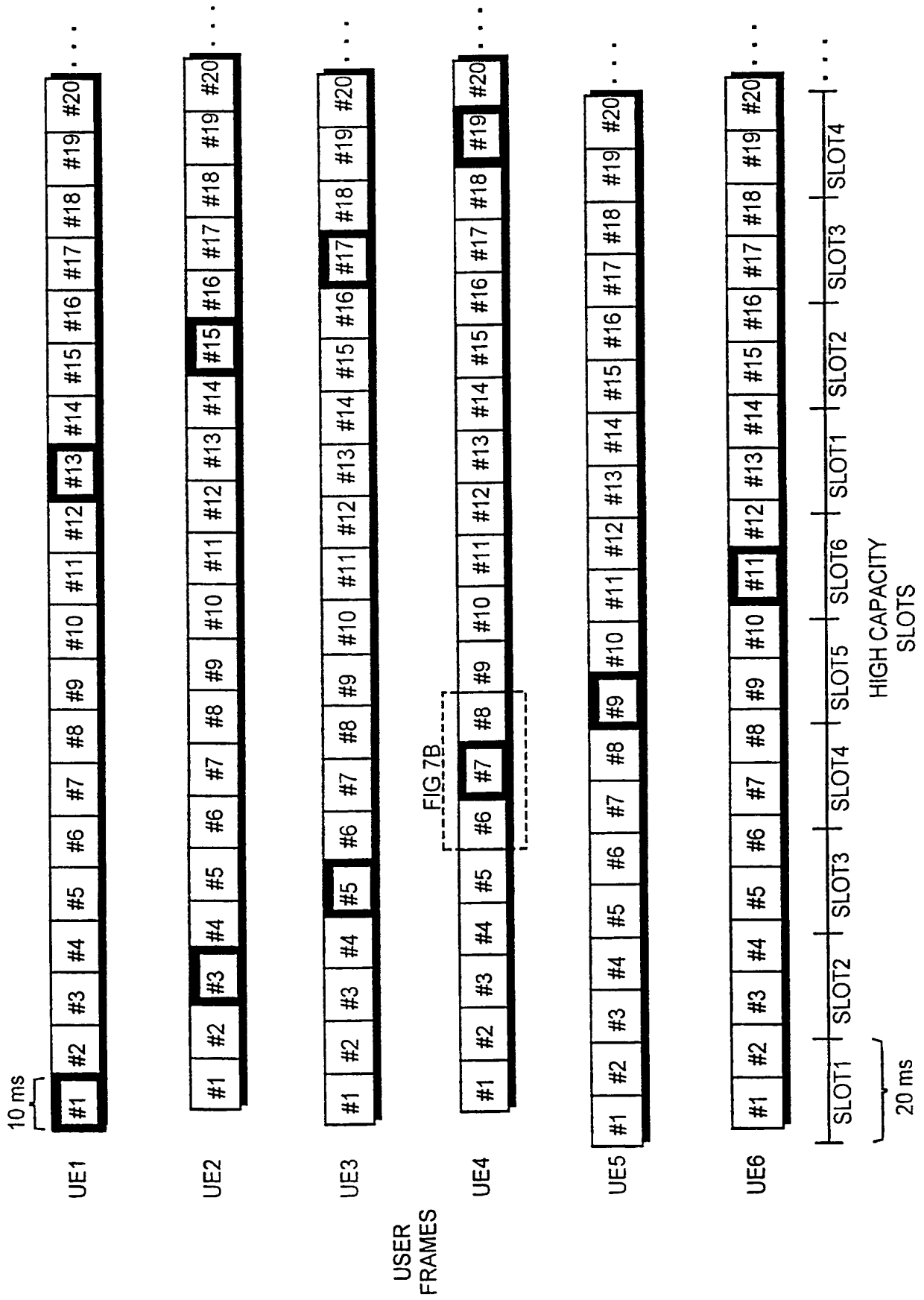


Fig 7A

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 99/00635

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 7/26, H04J 13/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B, H04J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPIL, EDOC, INTERNET, INSPEC

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 9523464 A1 (MOTOROLA, INC.), 31 August 1995 (31.08.95), figure 3, claims 1-10 --	1,6,8,16,21, 23,31,36,38
Y	EP 0693834 A1 (NTT MOBILE COMMUNICATIONS NETWORK INC.), 24 January 1996 (24.01.96), column 6, line 32 - column 8, line 54, figure 6, claims 1-44 --	1,6,8,16,21, 23,31,36,38
Y	US 5442625 A (RICHARD D. GITLIN ET AL), 15 August 1995 (15.08.95), column 1, line 45 - line 59, figure 5, claims 1-14 --	1,6,8,16,21, 23,31,36,38

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"I" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

14 December 1999

Date of mailing of the international search report

04 -01- 2000

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## INTERNATIONAL SEARCH REPORT

International application No.

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